Study on shelter response of Caritas Bangladesh for the Forcibly-Displaced Citizens of Myanmar

April-June 2018

September 2018

Report prepared by CRAterre in collaboration with Caritas Bangladesh, Catholic Relief Services (CRS) and Bangladesh University of Engineering and Technology (BUET)

Acknowledgment

First we would like to thank all the participants in the assessment, inhabitants of the new or long term camps but also from the host communities, who offered us their time and shared their analysis of the situation.

Thanks to government representatives for the valuable time they spent on answering our questions and explaining their practices and perspectives: RRRC officers, TNO, CIC, Palong Khali Chairman and Rajapalong Union Chairman.

Thanks to the Shelter/NFI Sector team for receiving us, giving us a clear overview of the situation and offering us the opportunity to meet with the involved agencies.
Thanks to I/NGO representatives from ECHO, IOM and UNHCR, but also to NGOs representatives from Obat helpers and Brac who participated in the study by sharing their experiences and recommendations.

Thanks to Caritas Germany for its support to this study.

Special thanks to the partners involved in this study, during the field assessment but also for developing and reviewing the present document: Caritas Bangladesh team, but also Catholic Relief Services (CRS) team and Bangladesh University of Engineering and Technology (BUET) professors.

Executive Summary

This study on shelter response of Caritas Bangladesh for the Forcibly Displaced Citizens of Myanmar has been conducted from April to June 2018, involving Caritas Bangladesh, Catholic Relief Services (CRS), Bangladesh University of Engineering and Technology (BUET) and CRAterre.

An assessment has been conducted in the human settlements mainly concerned by the displacement of population in Cox's Bazar district: recent camps, registered camps and host community villages of Ukhia and Teknaf. The same survey methodology, based on observation, individual house survey but also community meetings and focus groups discussions, has been adopted in the different contexts.

The present report focuses on the local building cultures identified in the visited areas and the first findings on the shelter situation there. The approach tends to valorise the good practices spontaneously adopted by the population to widen the range of shelter solutions that could be implemented in the next steps, for the recently displaced but also the long term inhabitants of the region. Another target is to report the main difficulties faced by the population regarding housing conditions.

A preliminary analysis of the mid-term shelters main options developed by Caritas Bangladesh and CRS is shared in this document in order to improve -as much as possible- the relevant solutions already developed.

A series of recommendations is proposed for the post-monsoon shelter response, and illustrated at the end of the document by technical proposals and references. The recommendations focus on strategies to reducing the vulnerability of the mid-term shelter options surveyed, valorising the existing housing strategies, promoting complementary slope protection approach or the use of known local materials and know-how, facilitating better cooking facilities, and finally improving the lifespan of materials.

Contents

1.	***Terms of reference***	***6***
1.1	Background:	6
1.2	Objectives:	7
1.3	Tasks:	7
1.4	Evaluation and Development	7
1.5	Research Methodology	7
1.6	Dissemination	7
1.7	Coordination	8
1.8	Deliverables	8
2.	***Recommendations for "phase 3" shelter response***	***9***
2.1	General	9
2.2	Mid-term shelters resitance to high winds is limited	9
2.3	Consider housing strategies developed by the population	9
2.4	Work on slope protection with bioengineering approach	9
2.5	Anticipate and adopt some of the spontaneous choices of materials & techniques	10
2.6	Consider the cooking facilities as a key issue	10
2.7	Improve the durability of materials	10
2.8	Implement housing programs in host communities	11
2.9	Develop practical training strategy	11
3.	***Research methodology***	***13***
3.1	Understand local building cultures (LBC)	13
3.2	Participatory approach & local building culture assessment	13
3.3	Locations considered for the study	15
3.4	Main risks in the region	17
4.	***New camps: emergency & upgraded shelters***	***19***
4.1	General information	19
4.2	Site	21
4.3	Site improvement	21
4.4	Shelter types	25
4.5	Shelter structure	29
4.6	Building process	31
4.7	Maintenance	33
4.8	Building materials	35
4.9	Skills for construction	36
4.10	Construction costs	36
4.11	Coping strategies	36
4.12	Findings	36
5.	***Registered camps: assessment of shelters development***	***37***
5.1	General information	37
5.2	Site	37
5.3	Shelter structure	39
5.4	Building process	41
5.5	Maintenance	43
5.6	Building materials	44
5.7	Skills for construction	44
5.8	Construction costs	44
5.9.	Natural hazard & Coping strategies	45
5.10	Findings	45

6. Host communities: local building culture assessment 47

6.1 General information 47
6.2 Shelter typologies 47
6.3 House structure 49
6.4 Building process 53
6.5 Maintenance 53
6.6 Building materials 55
6.7 Skills for construction 55
6.8 Construction costs 55
6.9 Main damages during disasters 56
6.10 Natural hazard & Coping strategies 56
6.11 Findings 57

7. Mid-term shelters models 59

7.1 Context 59
7.2 General principles 59
7.3 Shelter typologies 59
7.4 Shelter structure 61
7.5 Building materials 63
7.6 Skills for construction 63
7.7 Construction costs 63
7.8 Building materials 65
7.9 Skills for construction 65
7.10 Construction costs 65
7.11 Findings 67

8. Technical proposals 69

8.1 Use a “fuse element” in the roofing 69
8.2 Consider housing strategies developed by the population 71
8.3 Work on slope protection with biotechnological measures 77
8.4 Complement the range of solutions with locally employed materials 79
8.5 Cooking facilities 85
8.6 Improve the lifespan of materials 87
8.7 Also Implement housing programs in host communities 95
8.8 Develop practical training strategy 96

9. Annexes 97

9.1 Key informants 97
9.2 Assessment formats 98
9.3 Mid-term for displaced citizens of Myanmar Option 2 (2 units) drawings 118

Glossary

Borak bamboo	Bambusa balcoa Roxb.
CfW	Cash for Work
CGI	Corrugated galvanised Iron
CIC	Camp in charge
CRS	Catholic Relief Services
ECHO	European Civil Protection and Humanitarian Aid Operations
EMMA	Emergency Market Mapping and Analysis
ESK	Emergency Shelter Kit
FDCM	Forcibly Displaced Citizens of Myanmar
FGD	Focus Group
GoB	Government of Bangladesh
HCs	Host communities
HRP	Humanitarian Response Plan
IEC materials	Information, Education and Communication Materials
IOM	International Organization for Migration
ISCG	Inter Sector Coordination Group
KII	Key Informant Interview
LBC	Local building cultures
Majhi	Captain
Muli bamboo	Melocanna baccifera
NFI	Non-Food Items
NGO	Non-governmental organization
RCs	Registered camps
RRRC	Refugee Relief and Repatriation Commission
TDK	Tie down kits
TNO	Thana Nirbahi Officer
ToT	Training of trainer
UNHCR	United Nations High Commission for Refugees
USK	Upgrade Shelter Kit
WASH	Water, Sanitation and Hygiene

1. Terms of reference

1.1 Background:

Bangladesh is experiencing one of the worst humanitarian crises in its history due to the recent influx of refugees from Myanmar. A cumulative 605,000 new arrivals have entered Bangladesh since 25th August 2017, out of which 326,000 settled in Kutupalong Expansion Site, 233,000 in other settlements and camps, 46,000 in host communities, adding to the community of almost 350,000 longer term displaced Rohingya refugees who have settled in this location over the past 15 years1. According to the Inter-Sector Coordination Group (ISCG), the humanitarian situation continues to deteriorate. Cox's Bazar, with a population of 2,290,000 people, is already one of Bangladesh's poorest and most vulnerable districts, and without appropriate assistance this crisis is likely to further affect the relations with the local population.

The location has many environmental challenges in terms of the topography, poor access, and lack of natural resources. Basic emergency shelters have been constructed by the households using a range of plastic sheet, tarpaulin, bamboo and other locally sourced framing materials. Due to the lack of available ground, the sites are extremely congested with a total site average of 18 m2 / person which is substantially less than the SPHERE humanitarian standard of 45m2 /person. The lack of space results in small shelters with an average covered living space of about 2.5 m2 /person, which is also below the SPHERE humanitarian standard of 3.5 m2 / person. Shelters are constructed on steep ground on dug terraces, which creates a further risk of land slide.

The government of Bangladesh considers this displacement as temporary and does not want to encourage or permit permanent settlements. For this reason the types of construction materials that can be used are limited, and specifically the use of permanent masonry and sheet metal roofing is not permitted (CGI sheet is also restricted as the area is cyclone exposed). However, if the displacement is protracted the government may change its position or allow interim more durable solutions.

The Shelter/NFI Sector (a coordination platform part of the ISCG) together with government have developed a strategy that considers the immediate, medium, and longer term needs. This has been split into three phases that consider the monsoon and the potential risks of cyclone.

Phase 1 (through February 2018): Phase one activities are mostly completed for all but the new arrivals, with the sector distributing primarily acute emergency shelter kits of one tarpaulin and rope per household to support the refugee's own efforts to construct rudimentary makeshift shelters from bamboo and sticks. Sector partners will continue to support new arrivals with emergency shelter kits (including bamboo) in accordance with sector standards.

Phase 2 (November 2017 through April 2018): Site improvements and shelter upgrades with strong community participation will be carried out to meet the objective of improving living standards in the settlements and host communities. Shelter upgrade and site improvement kits comprising of materials and tools will be provided to communities in new settlements. Complementary to the distribution of kits, the sector will provide technical guidance[...] to enable people to build safer shelters and make localized site improvements. Community led initiatives will be supported to carry out neighbourhood site improvement works [...]. Improved drainage, access, establishment of ground cover, soil stabilization and reinforcement will be the prime outputs of the site improvements to both enhance living conditions and contribute to disaster risk reduction.

Phase 3 (September through December 2018): The response will incrementally move towards the provision of more appropriate and viable shelter solutions [...], which are intended to last for a longer timeframe. The ability to provide adequate shelter which meets international standards will be conditional on the availability of land and decongestion of settlements, as well as clear guidance from the government on acceptable building standards and materials. [...] Lessons learned from the monsoon season will inform further shelter and site improvement activities, which will complement the durable shelter solutions[2].

The Shelter/NFI Sector needs to identify appropriate solutions which are acceptable for the government, affordable, meet the challenges of the environment, and build upon the skills and capacities of the refugee and host population.

Caritas Bangladesh and CRS, with funding from UNHCR, have piloted the upgrade of shelters in one of the zones within Kutupalong camp. This included exploring shelter designs to increase the covered living area, including two storey options. This work may help to find options and strategies for longer term shelter.

---

1 As per Needs and Population Monitoring (NPM) 10 : In the assessment conducted between 1 and 20 May 2018, an estimated 915 000 individuals (approximately 215 000 households) were identified in 1922 locations. Of these, 85 % were living in collective sites, 13% in collective sites with host communities, and 2% in dispersed sites in host communities.

2 In Joint Response Plan for Rohingya Humanitarian Crisis 2018_https://www.humanitarianresponse.info/en/operations/bangladesh/document/shelternfi-joint-response-plan-rohingya-humanitarian-crisis-2018

1.2 Objectives:

The purpose of this study is to understand the current construction techniques developed and adopted to provide shelter and site infrastructure, such as pathways, steps, retaining walls and drainage. And with this knowledge, provide a range of appropriate technical solutions that are sufficiently durable for longer term shelter and that reduce risk from hazards, such as cyclones, rain, floods, landslides, and fire. Solutions need to be cost effective, adopt and adapt known techniques, to be culturally appropriate, and where possible, use locally available materials.

The study will provide information to the communities and to the agencies that are giving assistance, and help to inform strategy and advocate for appropriate approaches to be adopted and approved by the government. Information needs to be disseminated in ways that are accessible to all target groups, and identify effective methods of knowledge sharing.

The main research question is: What are the most appropriate strategy, design and construction options to provide durable, safe, and dignified shelters for the longer-term displacement population, especially the Rohingya?

1.3 Tasks:

Assessment

To be carried out in three areas:

- Local host settlements
- Long term refugee settlements
- New refugee settlements
- Proposed innovations by other actors and stakeholders

To include:

1. The cultural traditions and preferences for house design, including access, privacy, internal design, ventilation, thermal comfort, and facilities for domestic activities, such as cooking

2. Identify traditional and developed building methods that have been adopted both for emergency and longer-term shelter, including any skill or tool requirements, and transportation of materials and other logistic considerations

3. Identify the building materials that are used or could be used for construction, and make an evaluation of these materials in terms of cost, availability, durability, skills, speed of construction, specialist equipment, thermal comfort, and other factors that may be relevant such as seasonal constraints and environmental impact

4. Identify any incremental approaches to construction that improve functionality, cultural preferences, performance, safety, and durability

1.4 Evaluation and Development

1. Based on the assessment, identify best suited approaches to the environment and context for the construction and upgrading of shelters

2. Identify any design and construction developments that would improve the quality of the shelters and environment, and create increased covered living area, such as two storey and split level designs, or sleeping platforms.

3. Identify materials that are most suited for construction including affordability, availability, and environmental impact.

1.5 Research Methodology

1. Observation

2. Participatory – focus group

3. Key informant Interview (KII)

4. Academic research

1.6 Dissemination

1. Produce a report of the assessment and findings, including a description of the different design and construction techniques and any recommendations

2. Produce designs for shelters showing appropriate options for design and construction methods using different materials, including two storey options

3. Produce designs and details of robust methods and innovations for retaining walls, bridges, paths, ramps, and steps

4. The construction of demonstration buildings (to be constructed by Caritas and other NGO)
5. Presentation to the Shelter/NFI Sector, government and other stakeholders

1.7 Coordination

The study will involve CRAterre, Caritas Bangladesh, Bangladesh University of Engineering and Technology (BUET), and CRS.

The scope of work and responsibility is listed below:

CRAterre:

- Lead and direct the research along with CB, BUET and CRS
- Coordinate the assessment, evaluation, recommendations, and dissemination
- Produce reports and materials

Caritas Bangladesh:

- Assist in the field assessment
- Provide support for logistic
- Assist with coordination and access to government and other stakeholders

BUET:

- Review of assessment formats
- One visit during assessment and technical guidance
- Review of report
- Another visit during sharing of the report

CRS:

- Provide technical support and information about current CB shelter programs
- Assist in any design and demonstration construction
- Assist in dissemination

1.8 Deliverables

- Develop and present research methodology
- Written report to include:
- Research methodology
- Background research (academic reading, guidelines and information, etc.)
- Assessment
- Evaluation
- Findings and recommendation – including designs, pictures, graphics

To include 20 printed copies of the report and a PDF version

- Presentation to Shelter/NFI Sector and government department
- Introduction presentation at the start of the study to the Shelter Cluster
- Workshop - presentation and discussion with Shelter/NFI Sector technical working group
- Share to Shelter/NFI Sector, SAG, a Government Department

2. Recommendations for “phase 3” shelter response

2.1 General

The next step of the shelter response for the FDMC is the implementation of mid-term shelters. It was too late for implementing mid-term shelters at large scale before the monsoon.

Emergency preparedness for the cyclone and monsoon season remains the priority, with a narrowing window for risk mitigation measures.

After the monsoon many challenges will remain. There will still be a need to develop disaster risk reduction activities. It might not be possible to switch from the emergency or upgraded shelters to the mid-term shelters if no more land is allocated to the FDMC. Available land might not be sufficient in terms of surface and quality to shelter the targeted population in decent conditions. In the existing camps there is a need of restructuring before mid-term shelter implementation.

In this study we have not considered the two-storey shelter option for many reasons. It would substantially increase the wind load on structures and the constraints on the ground. Building one-storey safe shelters is already a real challenge considering hazards (especially cyclones), site condition (deforestation, soil stability), low quality of available, affordable, and acceptable materials.

2.2 Mid-term shelters resistance to high winds is limited

No matter how resistant the shelters are, they cannot resist to a cyclone. There are limitations in regards to the materials that can be used and those materials and techniques determine maximum wind speeds that can be resisted. Many improvements have been developed for the roof to resist very high winds like: secondary structure on top of the roofing tarpaulin, better joints, better tie down of the tarpaulin and roof, inside and outside bamboo tiara, permeable fence and ventilation on top of the wall.

But these structures are still light structures. The wind load first calculation provided by BUET identified that the weak point is the anchorage in the ground, which will depend on the way it is actually executed at a large scale implementation (quality of ground, compaction, etc.). And the wind load might be increased by “spontaneous” practices by the inhabitants like wrapping the shelter in a tarpaulin to make it more waterproof, site effect (top of hill + deforestation), etc.

Better foundations could be developed but there will always be a limit, and a risk that the wind load is higher than the limit. The risk is for the complete structure to be blown away, ripped from the ground, the whole shelter would then work like a “kite”. At the scale of a camp it would constitute a severe risk for the population.

A strategy is to use a “fuse”: before the shelter is blown away, the tarpaulin should open by itself. A “weakness” should be designed. It is compatible with the cost analysis of the shelter: tarpaulin cost is 6% to 10% of the mid term shelters cost.

(See 8.1)

2.3 Consider housing strategies developed by the population

Examples of low cost safe housing can be observed in the region and in other parts of Bangladesh exposed to similar hazards.

As observed in camps and host communities, people extend their house or shelter as soon as they can afford it. Many extension patterns can be studied in the registered camps for instance. When the space around the shelter is not sufficient, extensions settle on the paths even if it doesn’t fit with the needs of drainage systems, paths, etc.

The incremental strategy consisting in a *ghar* and *pasahchati* could be an option to consider for the shelter design and for the site planning. These constructions are adapted to the main hazards, and can last more than 20 years, though they are not considered as permanent houses.

(See 8.2)

2.4 Work on slope protection with bioengineering approach

During the study, the emergency was to relocate the more vulnerable Inhabitants. Everybody is conscious of the risks of landslides not only on slopes that have not receive enough consolidations but also on newly prepared areas (SMEP[3]).

Working on upgrading the shelter resistance and site improvement cannot be dissociated.

In parallel to all the soil consolidation work ongoing, there is a huge need to replant the slopes.

3 SMEP = program shared by IOM/UNHCR / WFP

Pilot studies are urgently necessary to stabilize the slopes using vetiver. Following the results, vetiver should be planted systematically and people need to be sensitized to the maintenance of the plants.

Planting vetiver would also create an opportunity to produce useful building materials such as thatch for roofing.

(See 8.3)

2.5 Anticipate and adopt some of the spontaneous choices of materials and techniques

Masonry works.

Mud masonry is commonly used in host communities and in registered camps in self-construction and self-recovery: material, know-how and skilled people are available, including for maintenance, finishing.

High potential for job opportunities (cheap material but high need of labour).

Green technology and locally available material providing thermal comfort, fire resistant, compatible with bamboo or RCC structures.

Easy to maintain but also to unbuild (only remove the roof, it returns to soil by itself).

Roofing.

Tarpaulin for roofing is a fast and safe material. For short time roofing it is also a cheap choice. But for long term use -for instance 25 years like in the registered camp- it turns to a financial burden for the householders because of its very short lifespan[4]. Comfort provided is low.

CGI roofing is adopted by the population in both host communities and long term refugee settlements as soon as people can afford the material.

This material is considered as a high risk in case of cyclone. It is possible to limit the use of CGI roofing in the new refugee settlements but not in the host communities.

Training the inhabitants to a safer use of the material and -if necessary- delivery of tools and materials would reduce the risk of incorrect use.

Thatch (leaves or straws) is used for roofing in host communities (2nd choice after CGI): cheap material, easy to replace, not dangerous in case of high winds. People adopt this material considering fire risk and maintenance constraints. But it is considered not available in the refugee camps[5]. A market assessment could identify the procurement issues and opportunities. Like bamboo, if local resources are not sufficient, a larger scale of procurement could be considered.

(See 8.4)

2.6 Consider the cooking facilities as a key issue

Spontaneously, people will cook inside, it is necessary to anticipate the risks : fire propagation in the shelter and between the shelters, but also the health issues due to indoor smoke.

Provide community cooking spaces would offer more safety and social opportunities

If not accepted culturally, then domestic solutions have to be integrated : environment friendly stoves, fire resistant fences / walls around stoves (including solutions for the interface between smoke pipe and roofing), fire / smoke resistant partition walls between rooms / shelters

Providing cooking fuel and environment friendly stoves would have a positive impact on deforestation, land erosion and risks of landslides, conflicts between host communities and new arrivals, health, etc.

(See 8.5)

2.7 Improve the durability of materials

The estimated time line for covering the total number of households with mid-term shelters is 3 years. This is possible that the need for shelters will last longer than initially planned. At the same time, the estimate lifespan of different components of the shelters is short. For instance untreated bamboo has as estimated duration of 1-3 years, depending on the design employed. So there is a need to adopt materials and practices that offer more durability to the shelters, especially mid-term shelters.

Durability of bamboo can be improved by : identifying new selection criteria for the available bamboo varieties, using details protecting the bamboo from humidity and insects, treating bamboo according to its use.

Though supply and availability of quality materials is a major problem, there is a need to train people to identify mature

4 The quality of tarpaulin people have access to is much lower than the quality of tarpaulin delivered by UNHCR or IOM for instance (made of woven HDPE fibres, laminated on both sides with lDPE coating, stabilized against ultraviolet rays and excess heat for long outdoor exposure.

5 All data presented here is the results of the 2 weeks field surveys and could be complemented by further inquiry.

Muli and *Borak* bamboos. Checking length and diameter of bamboos doesn't guarantee matureness of bamboos. For Guadua Angustifolia for instance, a bamboo culm reaches its maximum length and diameter within 6 months. Then it matures for 3-6 years. The selection criteria include : presence of juvenile leaves, stains on the surface, colour of the skin, thickness of the walls, internodal state.

Simple good practices can considerably extend the lifespan of bamboo or wood, for instance:

▪ Protect bamboo from humidity : dissociate the posts / beams from the ground, raise on a plinth or wrap in a protection membrane.

▪ Avoid direct exposure to rain and sun : wet/dry alternation reduces the lifespan and resistance of bamboo culms

▪ Treat bamboo according to the context. In host communities, both low toxicity chemical and water treatment could be implemented. But in new camps, considering the density of population and the very limited access to water, chemical treatment should not be implemented before other issues are under control: drainage and recollection of water, fuel for cooking and cooking facilities. The risk that chemicals leached from the treated bamboo contaminate water is high. The average available volume of drinking water per person per day is 4,3 l, the most commonly reported improved water sources were tubewells (87%) and piped water (10%)[6]. Rain water is used for bathing, playing, etc. Using treated wood or bamboo as cooking fuel is also a serious health issue (toxic smokes).

Even if the lifespan of materials can be upgraded, replacing of bamboo elements should be the easiest possible:

Dissociated bottom part of bamboo fence is a good example. Bamboo posts and bracing should also be quickly changed when necessary. Disconnecting bamboo post from the ground would facilitate the maintenance.

(See 8.6)

2.8 Implement housing programs in host communities

There is a need to counterbalance the pressure on host communities resulting from the humanitarian crisis by developing livelihood opportunities and housing solutions for the more vulnerable.

The issue of land scarcity faced in the camps is less severe in the host communities. There is an opportunity to develop a housing improvement program in this more favourable context.

Housing programs adapted to the host communities needs and social organisation could be developed, tested and improved. They could also be a reference for housing programs in the camps, if the situation turns to a longer term perspective and if they are accepted by the government.

The housing programs should include training on good practices to maintain, tie-down and repair existing houses considering the local hazards.

They could also include demonstration building : community building used as training for masons and carpenters, but also used as community shelters in case of need.

(See 8.7)

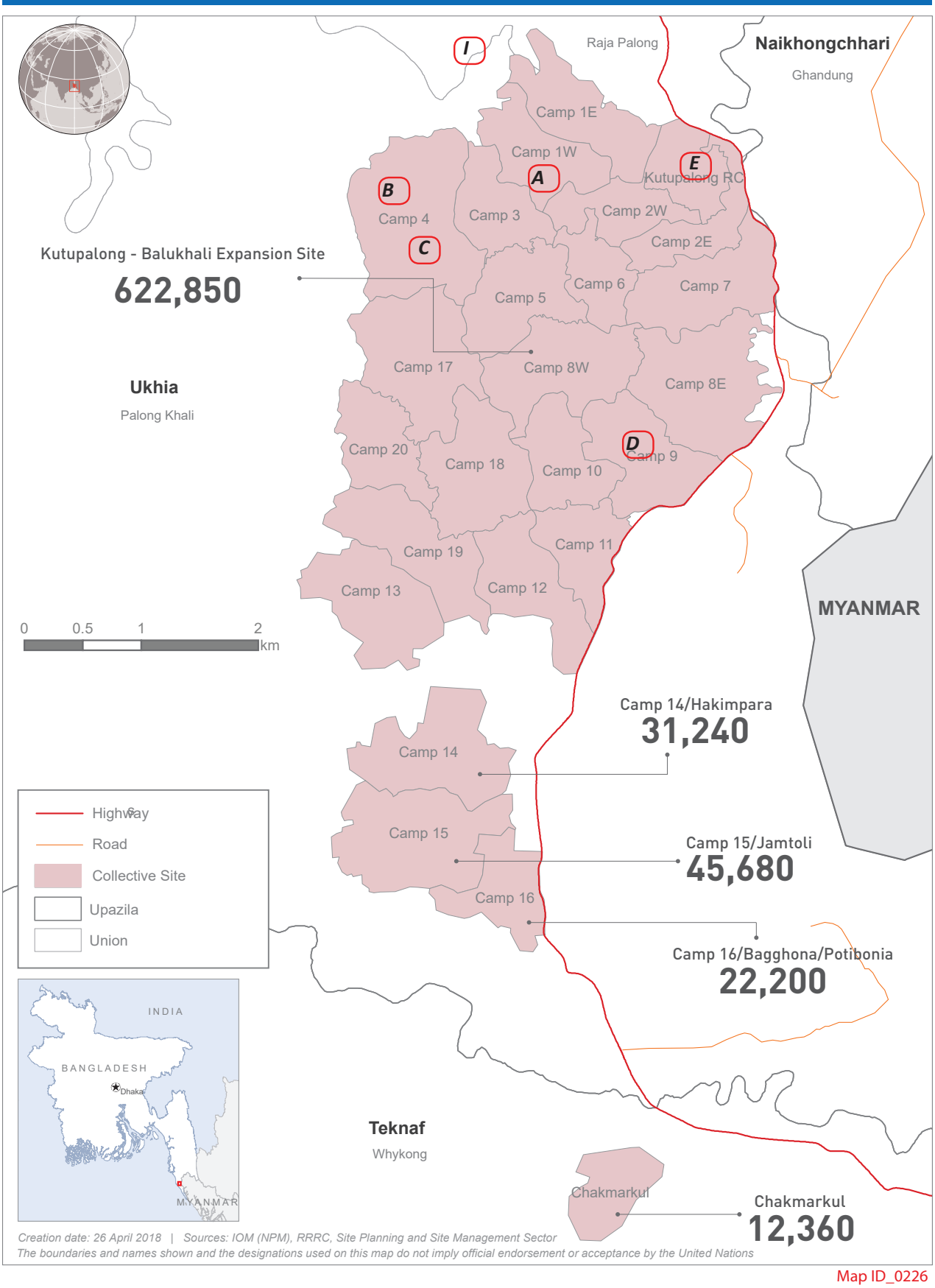
2.9 Develop practical training strategy

No matter what solutions will be implemented, the building of the shelters can only be realistic only with the participation of the population.

It is necessary to develop a practical training strategy to reach the expected quality for the shelter response, including different level of competence and responsibilities.

(See 8.8)

6 In Water, Sanitation and Hygiene baseline assessment: Cox's Bazar, Rohingya refugee response – April 2018. https://reliefweb.int/sites/reliefweb.int/files/resources/reach_bgd_report_wash_hh_survey_april_2018_0.pdf



Top:
Map of Cox's Bazar refugee population (Ukhia) as of 26 April 2018. ISCG

3. Study location information and local building culture assessment

The study locations are selected for FDCM camps, registered camps and host communities, and probable risks and hazards are reported for proper investigation. This chapter describes about specific survey procedures used to analyse and identify construction and architectural practices, to provide a sustainable shelter solution.

3.1 Selection of locations

The objective is to study the emergency shelter response, but also to analyse today's situation in the registered camps (with an experience return longer than 25 years), and the housing patterns out of the camps.

For these reasons the assessment has been conducted in Ukhia and Teknaf, in recent camps (hosting FDMC), but also in registered camps (refugee camps) and in host community villages. NB : This study is limited to the camps and rural areas directly around the camps. An additional assessment of the district including urban housing would be a valuable complement to this study.

Visited new camps:

- Kutupalong Camp 1 BB zone (A)
- Kutupalong Camp 4 PP zone (B) and UU zone (C) (areas of project implementation by Caritas Bangladesh)
- Kutupalong Camp 9 Balukhali (D)
- Nayapara new camp (F)

Visited registered camps:

- We considered the two registered camps from 1992, Kutupalong RC (E) and Nayapara RC (F).

Visited host communities:

- Mina Bazar, Teknaf (G)
- Sofiulah katah,Nayapara, Teknaf (H)
- Tengkhali, Jamtaly, Ukhia
- Kutupalong, Ukhia (I)
- Sofiulah katah,Nayapara, Teknaf (J)

3.2 Main risks

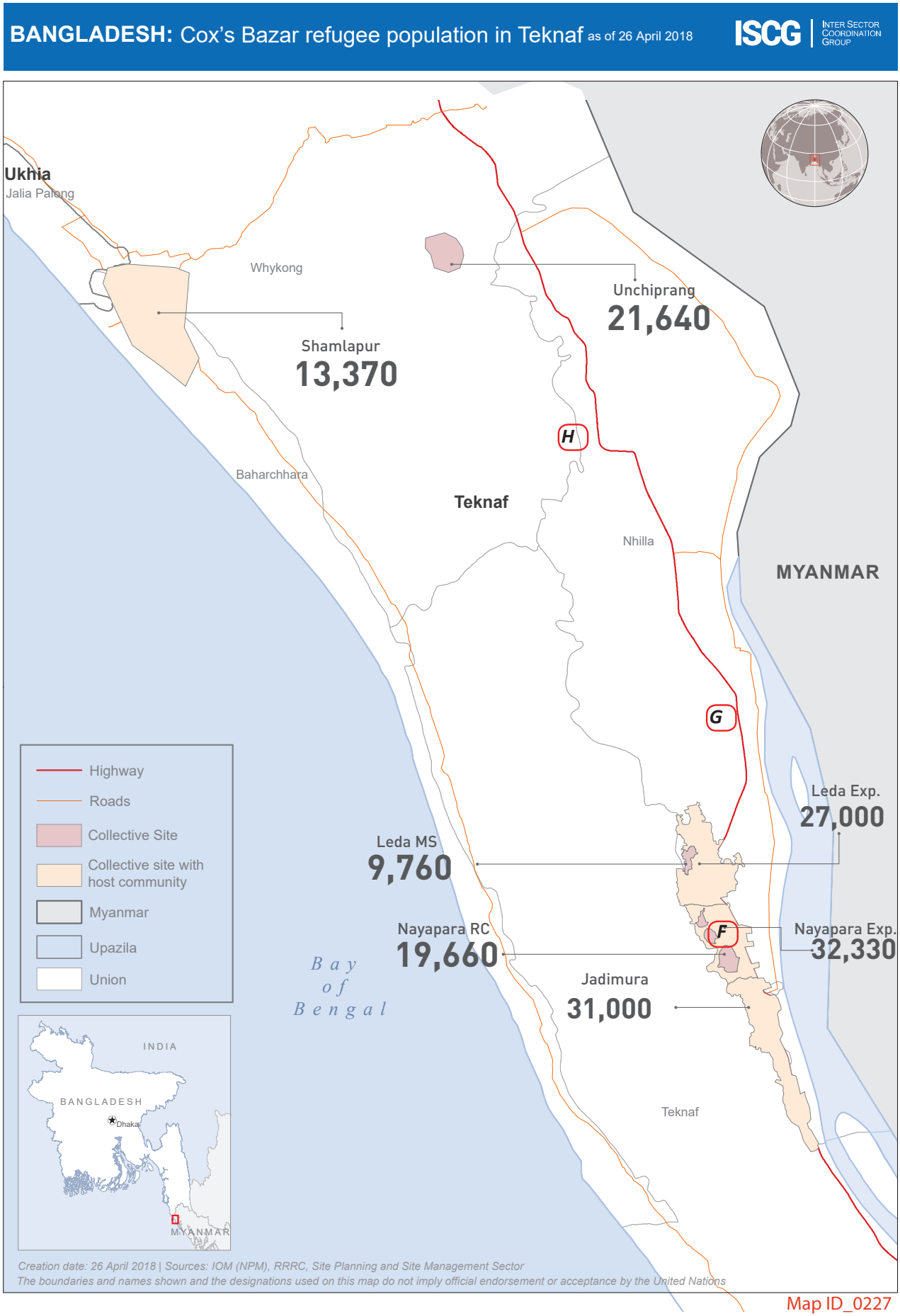
Risk analysis is important for a sustainable solution of shelter problems[7].

Natural hazards

- **Cyclone / tropical depression**
- Occurring April-May and October-November
- Exceptional events: severe cyclone storms includes winds up to 260 km/h (between 1877 and 2017 at least 17 cyclones stroke Cox's Bazar)
- Regular events: according to the surveyed 3 times per year (in the last three years Cox's Bazar has been impacted by a severe storm each year however none of these has been stronger than a cyclonic storm (more than 88 km/h or a category 1 cyclone)[8]
- Inhabitants consider the situation returns to normal after 2-3 days
- Main damages observed on shelters/housing: roof destroyed or partially damaged, damages on fences and walls due to horizontal rain, and food stocks lost.
- Main damages on environment: uprooted trees, crops lost
- Arrangement to reduce the risks: protection against storm surges is provided by coastal embankments.

Floods / flash floods

7 In Bangladesh National Building Code (2006)
8 In Cyclones Background, Rohingya crisis Thematic report march 2018



Top:
Map of Cox's Bazar refugee population (Teknaf) as of 26 April 2018. ISCG

▪ Risk for the flat lands. Estimate population in need for relocation from flood-prone areas: 25 000 households

▪ Occurring during monsoon

▪ Main damages observed on shelters/housing: plinth / food and belongings damaged

▪ Main damages on environment: land-slides

Earthquake

▪ Exceptional event: 7 major earthquakes affected Bangladesh in the last 150 years

▪ Regular events: the earthquake record suggests that since 1900 more than 100 moderate to large earthquakes occurred in Bangladesh[9], out of which more than 65 events occurred after 1960.

▪ Interviewed people in the camps are not aware of the earthquake risk.

3.3 Understand local building cultures (LBC)

All over the world, societies have always been able to produce, adapt and develop their habitat, according to their needs, interests and abilities, making the best use of locally available materials. The strategies developed to take advantage of natural resources and, at the same time, protect populations from the destructive forces of nature, have generated rich and varied knowledge at local levels.

(Re)discovering the intelligence of local architectures through their analysis and the analysis of the associated practices is essential. This will contribute to the creation of disaster resistant architectures in tune with contemporary lifestyles and their evolutions, respectful of the local environment (avoiding over-exploiting natural resources when demand is very high in reconstruction) and culture, and adapted to the technical and economic capacities of local populations.

Relying on local knowledge, know-how, construction organization and traditional means of communication turns out to be very effective with regards to:

▪ The implementation of solutions adapted to inhabitants ways of life and the suggestion of improvements according to their needs thanks to the strong involvement of local populations in the projects. Building on existing practices and the involvement of inhabitants in the projects encourages greater short and long-term ownership over reconstruction projects.

▪ The possibility to shelter many people quickly and cost-effectively taking into account seasonality effects.

▪ The large-scale reproducibility of the improvements designed in continuity with local building cultures and an easy access– both financially and technically – to the promoted solutions for non-beneficiaries.

▪ The positive impact on local economy as local skills and materials are fully promoted.

▪ The empowerment of inhabitants, recognition of their valuable capacities and the improvement of their resilience.

The final aim of this approach is to develop a disaster-resistant architecture adapted to current local ways of life. This includes an adaptation to the environmental, cultural and social specificities of inhabitants and to their technical and financial abilities.

It is important to invest in inhabitants and local professionals' empowerment. [10]

9 In Seismic micro zonation of cox's Bazar municipal area.

10 Concerning the local building cultures of Bangladesh, a Detailed shelter response profile has been developed by the Promoting Safer Building Working Group within the Global Shelter Cluster: BANGLADESH, Local Building Cultures for sustainable and resilient habitats. Document available on : https://craterre.hypotheses.org/2233

top :
Community meeting, PP zone Kutupalong
bottom:
FGD artisans, UU zone, Kutupalong
FGD artisans, Host community, Kutupalong
Individual shelter survey, BB zone, Kutupalong

3.4 Participatory approach and local building culture assessment

The assessment has been conducted in recent camps, in registered camps and in host community villages. In these three contexts, we used the same participatory approach, consisting in:

- Observation during accompanied visit of the settlement
- Community meetings
- Focus groups with artisans
- Interviews of households
- Interviews with key informants

Survey formats have been elaborated for the study[11]

- Check list for Community meetings
- Individual shelter survey
- Check list for meetings with local artisans
- Questionnaire for materials suppliers

Related information

Arjumand H., Shahidullah M., Dilder A..The Bangladesh Cyclone Preparedness Program. A Vital Component of the Nation's Multi-Hazard Early Warning System

Imtiaz A.B.A (2009), Seismic micro zonation of cox's Bazar municipal area, Thesis submitted to the department of Civil Engineering, BUET, Dhaka.

Inter Sector Coordination Group / Rohingya Refugees Response - Operational Overview

NPM-ACAPS Analysis Hub: Cyclones Background, Rohingya crisis Thematic report march 2018

Shelter cluster (2018) Detailed shelter response profile: BANGLADESH | Local Building Cultures for sustainable and resilient habitats 1st edition: September 2018.

Shelter working group Bangladesh (2009) Post-Cyclone Sidr Family Shelter Construction in Bangladesh Documentation of Plans and Processes

Strategic executive Group (2018) JRP for Rohingyas humanitarian crisis March -December 2018

William M.(2017). Final Emergency Market Mapping and Analysis (EMMA) report

11 See annexe 9.2

top :
Children friendly space, UU zone Kutupalong

bottom:
Children friendly space, BB zone Kutupalong
Children friendly space, level, Balukhali Kutupalong camp 9

3.5 Main risks in the region

4. New camps: emergency and upgraded shelters

At first, emergency shelters were provided and later upgraded shelters were supplied. This chapter describes the geometry, shapes, and materials used for types of shelters.

4.1 General information

Emergency shelters and Upgraded shelters implementation

- Needs: 207 000 households (approximately 900 000 persons [12])
- Covered: 180 000 households received ESKs and 140 000 households received USKs to improve their shelter[13]
- Modalities of implementation:
    - Most agencies only deliver ESKs and USKs to the households through the distribution centres in the camps.
    - Some agencies[14] provide technical assistance consisting in practical demonstration of main components of an upgraded shelter (on site training): drainage around the shelter / plinth / anchorage of bamboo post with cross-element / bracing
    - Trainees do not obtain any certificate of capacity, but are registered by the implementing agencies.
    - Registered trainees are more likely to be recruited for cash-for-work construction works (communal facilities, drainage, etc.)
    - Few agencies pay the beneficiaries (approximately 50 BDT/hour) for the construction of the shelters[15], mainly for the extremely vulnerable families.
- Timeline : target is to reach every household before monsoon

Main activities

Main livelihood activities: FDMC are not supposed to work. Only cash-for-work opportunities are offered by implementing organisations for:

- Site improvement
- WASH facilities construction
- Shelter construction for the more vulnerable

Infrastructure

Hazard factors:
- Location top of hills
- Scale of construction increases wind load

Technical issues:
- Corrugated Iron (CGI) roofing is not always properly secured on structures such as latrines and mosques. In the event of heavy winds, improperly secured CGI roofs are likely to fly through the air, a danger to people in the sites. In addition, CGI is likely to easily penetrate plastic sheeting of shelters. [16]
- Need for water, sanitation and hygiene (WASH) facilities;

Comfort factors:
- Thatched roof
- High ventilated spaces
- Ceiling (bamboo mats)
- Cement plaster on the floor
- Brick plinth

12 There are approximately 941,000 Rohingya people living in Cox's Bazar camps. Of these 681,000 are new arrivals since August 2017

13 In Inter Sector Coordination Group, Situation report: Rohingya Refugees Cox's Bazar 10 May 2018

14 IOM provided Technical assistance to 99.9% its beneficiaries (preliminary training)

15 For instance Obat Helpers

16 In NPM-ACAPS Analysis Hub: Cyclones lessons learned Rohingya crisis Thematic report-April 2018

Top to botton :
General view of PP zone, Kutupalong
Stairs and drainage, BB zone, Kutupalong
Stairway made out of cement bags filled with mud, PP zone, Kutupalong

4.2 Site

Morphology

▪ Hilly region, altitude 100-200 m. Covered with vegetation and trees before the massive arrival of FDMC.

▪ Handmade terraces have been achieved by the beneficiaries.

Access

▪ Most of the shelters / houses are not directly accessible by the roads.

Location of shelters and use of land nearby

▪ The shelters are distributed on the slopes, following the main level lines. Considering the important demand for shelter and the restricted available land, the only use for land is shelters and communal facilities. Very few land is left for other activities such as playgrounds, fields. Very few green areas are available.

4.3 Site improvement

The main site improvement concern slope stabilization elements, secured paths and drainage systems:

▪ **Sand bags and earth bags** piled up to create retention walls, pedestrian paths and stairs .

▪ The bags used for the soil stabilization (made out of plastic or burlap) have a very short lifespan.

▪ After 3 months most of them are torn, letting out the sand +cement (6:1) mix or mud.

▪ **Pedestrian bamboo bridges**

▪ Quality of such bridges is not homogeneous:

- Safe bridges present safe structure including safe bridge deck and guard rail.
- But some bridges are not maintained, have very high post, no guard rail. These bridges have a short lifespan, the bamboo structure and deck are very exposed to the elements (no protection from sun and rain) and decaying agents (posts buried in the ground, then dipping in the rivers, no treatment).

▪ **Drainage**

▪ Efforts are being made to develop a fast and effective drainage system at 3 different levels:

- "Shelter" level: basic drainage dug in the ground on the surroundings of the shelter (not structured) by the beneficiaries
- "Paths" level: the domestic drainages are connected to bigger drainages, with a 1'x1' section in most of the cases.

▪ In BB zone the drainage is reinforced by bamboo posts and a cement plaster (better condition than in other zones).

In PP zone the drainages are built with brick (wall), plaster and net-cement finishing the surface

- "River bed" level: all the drainages are led to the riverbed, downhill.

There is few consolidation of the riverbanks. In camp 9-Balukhali, main drainage is consolidated with earth bags and bamboo posts.

The drainage at"paths" and "riverbed" levels are built with implementing agencies, as cash for work activities.

The dimensions of these elements should respond to the specific location where they are implemented (depending on the watershed). A standard section can not be defined for all locations.

There is a high need for maintenance of the drainage system, if not the risk of flooding is increased (for instance, torn polythene pieces may cause many problems). No maintenance committee organized so far.

Raised path and bamboo bridge, Nayapara new camp,
Bamboo bridge Nayapara new camp
Raised oath and bridge, PP zone, Kutupalong
Unsafe bamboo bridge, Camp 3 , Kutupalong

top :
UU zone, general view
Right:
3 types of drainage:
Shelter level
Path level, BB zone Kutapalong camp 1
Riverbed level, Balukhali Kutupalong camp 9

top :
Emergency shelter (right) & Upgraded shelter (left), Naya-para new camp
bottom:
Inside Emergency shelter, low structure

4.4 Shelter types

Shelters can be of different orientations, sizes and made of different materials.

Main types of shelters existing in the area

The shelters are built out of a bamboo frame covered with plastic sheeting (local name: *Juphri* shelters), and result from the distribution of Emergency shelters kits and Upgraded shelters kits, and materials purchased by the FDCM.

BB zone project (implemented by Caritas Bangladesh and CRS) has been the pilot for the development of the USKs.

The main differences between the emergency shelter and the upgraded one are:

- Better tarpaulin quality (most emergency shelters are covered with polythene).
- Better structures : joints /number of posts/ introduction of bracing.
- Improvement of the fences and roof adding bamboo “tiara” as a reinforcement.
- Better tie-down of the roofing.

Shape and size, orientation, space arrangement, particular elements

- Shape and dimension are resulting from the size of delivered tarpaulin. Common dimensions for an upgraded shelter are 16’x12’.
- Orientation is resulting from the platforms cut on the hill. No major orientation observed.
- People try to create 2 rooms as soon as possible, dividing the general volume with a bamboo fence or tarpaulin into 2 similar rooms (8’x12’).
- Entries are disposed at the 2 extremities of the shelter most of the time.
- Particular elements: platforms, “mezzanine” storage.

Additional buildings

- Communal latrines and bath rooms are distributed in the camps. Some shelters include a space for bathing.

Extensions

- A veranda is a common extension, starting with a roof, quickly completed with a mud plinth and bamboo fence.

Comfort

- Indoor climate is particularly hot, the tarpaulin roof is not providing any protection from sun radiation, and cross ventilation insufficient.
- Privacy is very low, mostly when the shelters are clustered.
- Security is considered very differently by the surveyed people, from acceptable to very low.
- Inside cooking is a source of discomfort.

Top:
Upgraded shelter cluster, BB zone Kutupalong

Bottom:
2 pitched roof Upgarded shelter, BBzone Kutupalong
4 pitched roof Upgraded shelter, BB Kutupalong
External bath and latrines, PP zone Kutupalong

Top:
extension of upgraded shelter, veranda, PP zone Kutupalong
Bottom:
Extension of Upgraded shelter, with bamboo +tarpaulin, PP zone Kutupalong
extension of upgraded shelter, Balukhali camp 9 Kutupalong

Top :
Fence composition, including ventilation lattice «Garenja», BB zone Kutupalong
Left :
Bamboo joints with GI wire
Bamboo post in ground + bamboo bracing, BB zone Kutupalong
Right
Roof used for drying materials, BB zone Kutupalong

4.5 Shelter structure

It is important to construct every part of the structures properly for proper maintenance and performance.

Drainage

▪ From very basic earthen drainage to earthen with cement plaster supported by bamboo wall (BB zone).

Foundations/plinth

▪ Mud plinth, 6'' to 1' height, made out of mud available on the plot.

▪ Mud plaster for floor finishing, use of better quality mud (brought from nearby ground or from larger distance).

▪ Erosion of mud plinth is considered a weakness. In some cases the tarpaulin fence is covering the mud plinth.

▪ Mud plinth is considered a sacrificial layer, and is regularly maintained.

Main structure

Bamboo structure:

▪ Main structure is built out of *Borak* bamboo (3 -3''1/2 diameter used mostly).

▪ Secondary structure is made out of *Muli* bamboo (2'' to 3'' perimeter).

Posts are buried in the ground, a cross element (1' bamboo piece) tied at the base to improve the anchorage of the post.

Bamboo is not treated nor seasoned, as the demand is acute and the season for cutting bamboo is ending, quality of bamboo is decreasing (immature bamboo is procured). First termites' attacks can be observed after 2 months.

Roof

▪ 4 pitched roof /2 pitched roofs.

▪ Bamboo structure composed of *Borak* bamboo (3''1/2 to 5'' diameter) and *Muli* bamboo – covered with tarpaulin.

▪ Strengthened by bamboo *tiara* and/or rope.

▪ Loaded with mud bags and/or tied to the ground with rope.

Roof is used for drying wood and other materials used for fire cooking.
In some case people grow vegetables on the roof (pumpkins for instance) which provides shade but might also bring overload issues during monsoon (stagnant water) and risk of fast sapping of the roofing material.

▪ Cloths ceiling or cardboard ceiling is added to improve thermal comfort indoor

Fences

▪ Tarpaulin fences structured with bamboo *tiara* (4'' wide bamboo grid).

Most of the shelters are completely wrapped in tarpaulin, without any ventilation between fence and roof.

Joints

▪ Bamboo posts and beams are tied together with : rope, wire, polypropylene straps (PP straps).

▪ Cuts are made with machete, very approximate.

Material for tying (rope / wire / PP straps) are most of the time very thin and loose because of the drying of the bamboo elements after the construction.

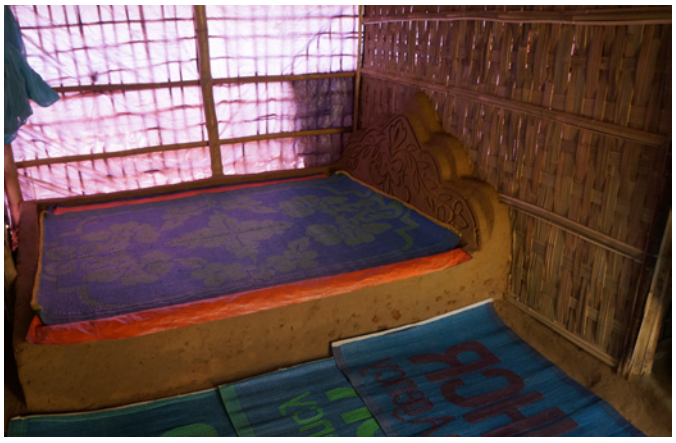
Openings

▪ 2 doors is a common practice, 5'6''-6' high by 3'.

▪ No windows in most cases.

▪ Ventilated top part of the wall (bamboo *Garenja*) is observed but not the main practice.

Ventilation at the top of the wall (1' under roof) reduces the indoor temperature. And it reduces the wind load in case



Top:
cooking space, mud plaster protection of fence, BB zone Kutupalong
Bottom
cooking space, fire risk on fence, BB zone Kutupalong
Mud platform
Clothes ceiling / Cardboard ceiling, PP zone Kutupalong
Growing vegetation on tarpaulin roof (risk of fast decay), BB zone Kutupalong

of high winds but the protection from rain is not satisfying.

Special provisions

▪ Bamboo platform, mud platform are built to create a raised place for storing goods and having a dry place to sleep.

▪ Cooking place inside the shelter, consisting in a mud stove, or in some cases in a gas stove provided by the implementing agencies. Sometimes the fences facing the stove are covered by a fire resistant plaster (mud plaster). No smoke pipe.

▪ Hanging shelves, mezzanine storage are quickly built by the inhabitants. Mezzanine are not considered as traditional elements by the surveyed but respond to a need considering the very restricted space available in the shelters.

▪ Verandas are commonly added to the shelter to provide a ventilated place for daily activities.

▪ Shaded paths with vegetation are implemented in BB zone (pilot project).

4.6 Building process

Criteria to choose: house position, house materials, artisans

▪ The plots are normally allocated to households by implementing organisations, according to the site planning (UNHCR). The distribution is independent to relations between households (same family, same origin).

▪ The employed materials are the ones delivered in the kits. Some extra materials are added and chosen by the beneficiaries (clothes for ceiling for instance).

Construction season:

Not applicable in the emergency context. The goal is to organize the shelter for most of the FDMC before monsoon, including the relocation of people from risky plots.

Duration of construction

▪ Emergency shelter is built in 2 days by 4 persons.

▪ Upgrading the shelter takes 3 days by 4 persons.

Construction process

▪ These very rudimentary constructions are built in one step, including floor levelling, lay-out, pillar setting, truss, roofing, fencing, door setting and floor finishing.

▪ Householders build and upgrade the shelters. The most vulnerable households receive the help of other FDMC (paid by NGOs).

Ways to reduce construction cost

▪ Beneficiaries receive the materials at the distribution centre and build a shelter on site, in most of the cases on their own.

4.7 Maintenance

Average lifespan of the shelters

It is too early to say, but according to some of the KII, new USK will be needed for the same beneficiaries to maintain, repair or rebuilt the shelters in the next months (monsoon).

Average lifespan of the materials

The interviewed people don't have a precise idea on the lifespan of the different components of the shelters. Estimate lifespan of the elements of an upgraded shelter:

- Bamboo posts buried in ground (immature + untreated) : 6 months
- Bamboo beams and rafters, purlins (immature + untreated but dry) : 12 months
- Bamboo mats and *tiara* exposed to rain + sun : 6-12 months
- Tarpaulin: 6 months (tarpaulin delivered by agencies are UV treated to resist longer than common tarpaulin).

Main parts that need maintenance

- Plinth:

The plinth needs maintenance mostly during rainy season because it is very exposed. Main reasons for fast erosion of plinths are : no plaster for finishing, small roof hanging, no gutter, and insufficient or not maintained drainage system.

Good practices observed consist in : maintenance of drainage, frequent re-plastering with mud mortar, good overlap of tarpaulin in front of the plinth. Some inhabitants apply a mud plaster prepared with better quality clay when the material is available nearby.

NB: use of cement stabilized plasters as protecting coating is not efficient (expensive for short time effect), as it is not very compatible with mud masonry and prevent the drying of the plinth due to the absence of any damp proof course in these constructions. Humidity accumulates in the mud plinth which reduces its durability, instead of increasing it, and the cement plaster rapidly dissociates from its support.

- Flooring:

The floor, mud floor in most of the shelters, needs weekly maintenance. Mud plaster applied 1-2 times / week by women.

PP floor mats are used to cover the mud floor when sitting / sleeping. Easy to clean, remove.

- Roof:

The tarpaulin tends to accumulate water, then water drips inside. Needs to be cleaned from stagnant water, re-stretched and tied. Fast decay because of UV, and mechanical stresses. Changed after high winds (torn or blown away).

previous page
top :
Mud plinth to be maintained
center :
bamboo joints with GI wire and PP straps, resistance?
Termites attack on bamboo after 2-3 months
bottom
Bamboo decay due to running water
Bamboo cracking due to hammering

Top:
Bamboo stored directly on the ground, no rain nor sun protection.
Left:
Muli bamboo ready for delivering, presence of leaves might be a sign of immature material
samples of bamboo mat and bamboo mesh, produced locally

4.8 Building materials

BUILDING MATERIAL	AVAILABLE / PROVENANCE	CHARACTERISTICS / REMARKS
WOOD	No	/
BORAK BAMBOO	Yes / from Sylhet, Chittagong, Dhaka, Mymensingh, western part of Bangladesh	Immature Untreated Green
MULI BAMBOO	Yes / Chittagong, Lama, Sylhet, Myanmar	Immature Untreated Green
STONE	No	Only alluvial ground in the region
GRAVEL	No	Brick chips are used as aggregates in local concrete works
MUD	Yes / local ground	Uneven, appropriate for construction in some parts (good examples of mud masonry observed)
THATCH	No	/
TARPAULIN	Yes (UNHCR/IOM)	Shelter grade or polythene
CGI	Yes / local market	No data
WIRE	Yes / local market	Low quality
ROPE / PP STRAP	Yes / local market	/

BUILDING MATERIAL	COST (BDT)	DIMENSIONS
BORAK BAMBOO	300-400	Long >25' Perimeter >8''
MULI BAMBOO	40-50	Long >16' Perimeter 2''-3''
MUD	Only transport cost when required	N/A
THATCH	No data	/
TARPAULIN	2000	4x5m / 4x6m (170g/m2)
FLOOR MAT (PP)	300	1.8mx09m / 450 g/m2
GI WIRE 18 GAUGE	105	Kg
ROPE / PP	135-150	Kg
BRICKS	7-10	(Unit) 10x20cm

Durability:

The main problem is the durability of bamboos. Its quality is decreasing severely since January. Quality of bamboo now available is problematic because:

- Bamboos are cut when immature.
- While the production of bamboo and timber is year-round, bamboo harvested during the monsoon season will be of better quality for construction (due to its dryness and resistance to insects)
- The demand is huge (for reaching the USK target there is a need of approximately 10'800'000 *Muli* bamboos + 720'000 *Borak* bamboo[17])
- The procurement modalities are difficult to settle
- Storage is not appropriate

Interviewed people have no suggestions to improve the durability of bamboo

17 in EMMA report

4.9 Skills for construction

Number and types of artisans available in the area

The FDCM people consist of with a large number of skilled builders, including masons, carpenters, and craftsmen mastering bamboo works (bamboo joints but also bamboo mats /fences). In Rakhaine, most of the households build their own house.

4.10 Construction costs

Average costs of existing shelters

- Upgraded shelter average cost: 20'000 BDT (including 1 tool kit/ 5 households)
- Materials: 10'000 BDT according to Emergency shelter/NFI kit
- Labour cost = 400 x 12 = 4'800 BDT

Most expensive part of the shelter

- Bamboo posts and Tarpaulin

4.11 Coping strategies

Cyclone / tropical depression

- **Before disaster:**
- The type of information dissemination in case of cyclone warning that has worked in the past includes the use of megaphones and radio.[18]
- Most people explain they would tie down the shelter with ropes to the ground. (People haven't experienced such disasters in the camps, but expressed their former experience in Myanmar).
- **During the disaster:**
- At the time of writing it was clear that there were no evacuation plans for the Rohingya population. Reasons for this : movement restrictions, scarcity of land, and a lack of usable, stable structures to relocate people. In case of a cyclone, the government will instruct host communities to seek safety in cyclone shelters, though the number of cyclone shelters is inadequate.
- Most of the surveyed households answered that they would stay in their shelter or go to a stronger house nearby or a communal shelter: school or mosque.
- **After the disaster:**
- Interviewed people focus on the needs for repairing roof.

4.12 Findings

Upgrading of the emergency shelters is a major improvement. The adopted strategy allowed to reach the targeted population (180 000 households). It is now being completed with the delivery of Tie-down kits and IEC material so that people are better prepared for the monsoon and cyclone risks.

A new design of "Reinforced emergency shelters" starts to be implemented. The type of the shelter is a cluster of 2 shelters (15'x12'4''). The structure is braced at all levels, the pitch is 25°, a *Garenja* on top of fences provides ventilation on all sides, the plinth (1' high approximately) is consolidated by 2 layers of sand bags.

The main identified issues are :

- Organizing the maintenance of the drainage system and paths, steps, retaining of slopes. A drain maintenance group/caretaker for regular clean and maintenance of the drain system is required, as well as building up awareness about drain maintenance.
- Low quality and durability of materials: continued delivery of materials and replacement of drainage and site improvement facilities might be necessary.
- Upgraded shelters can not be considered as cyclone resistant shelters and there is a severe lack of community shelters
- Indoor comfort is low (in terms of ventilation, sun radiation,etc).

18 In Rohingya crisis: Lessons learned about the impact of cyclones, ACAPS NPM Analysis Hub. Thematic report April 2018

5. Registered camps: assessment of shelters development

The main features of the registered camps, site morphology, local information and shelter structural forms are discussed in this chapter.

5.1 General information

POPULATION IN REGISTERED CAMPS	
KUTUPALONG	35'000 (5'000 households)
NAYAPARA	27'000[1]
AVERAGE FAMILY SIZE	4.3 persons

INFRASTRUCTURE AND FACILITIES	
NUMBER OF SCHOOLS	12
NUMBER OF COMMUNITY BUILDINGS	2 Mosques
NUMBER OF HEALTH CENTRES	2
SOURCE OF CLEAN WATER	Tube well
TYPE OF LATRINES PEOPLE USE	Communal latrines
DRAINAGE	*Pucca*[2] drain
SOIL STABILIZATION	Earth sand filled bags

Main activities

▪ Male are engaged in various types of wage labour outside of the camps, including: salt making; brick making; fishing; agricultural work and construction work

▪ Women, on the other hand, tend to remain in and around the camps, engaged in activities such as: domestic work; tailoring; fishnet-making; embroidery; water collection and chilli grinding.

▪ Depending on the labour market and on gender, the refugee can normally expect to earn between BDT 100 to 300 per day.[19]

5.2 Site

Morphology

▪ Flat area in the hilly region.

▪ Rare green spaces but some trees provide shade in the camp.

Access

▪ Most of the shelters are not directly accessible by road, but mainly by narrow paths.

▪ Brick flooring on major axes of the camps and local *bazar* (work in progress).

▪ Other paths are earthen tracks.

Location of shelters and use of land nearby

Shelters location respond to the site planning of 1992 (construction of the RCs).

▪ There is one main type of shelter, clustered shelter, repeated in both camps.

▪ The shelter unit is 15'x15', originally consisting in one open space, with asymmetrical 2 pitched roof.

▪ Most of the shelters have been improved: partition walls, platforms, etc.

▪ A cluster ("colony") counts 6 units in a raw.

Additional buildings

▪ Wash facilities are external. Some households equipped their shelter with a bath.

19 In Joint assessment mission, Myanmar refugees in Cox's Bazar District, Bangladesh, December 2012

Top:
Drainage

Left:
End-of-raw shelter, resting on a mud platform
CGI fence on gable wall , and CGI plinth + bamboo fence on sides.

Extensions

Nowadays most of the shelters have 1 or more extensions: veranda, corridors, rooms, bathrooms, and kitchen. All these extensions are built by the refugees (by themselves or with the help of waged artisans –from the RC).

Comfort

Inside comfort is very basic, the main issues are:

- No privacy in the shelter, and no privacy between the clustered shelters.
- Smoke from indoor stoves causes health problems (mostly for women and children) and fire risks.
- No thermal insulation (tarpaulin roofing and CGI fences).

5.3 Shelter structure

Drainage

Semi *pucca* drain with cement sand finishing.

Foundations/plinth

- Shelters are settled on a mud plinth (1' to 1'6''). Cement plaster for floor and plinth (at least at the entrance) is one of the first modification done when inhabitants can afford it.
- The main structure doesn't rest on any foundation.

Main structure

- RCC pillars are founded directly in the ground
- RRC pillars are T-shape 5''x5''x 9' or 10' or 11' tall. Space between pillars 5'.

Roof

- The clustered shelters share a 2 pitched roof.
- Structure: wood purlins and bamboo +wood rafters
- Roofing: Bamboo *tiara* + tarpaulin
- Roofing anchorage / loading: bamboo *tiara* or net + wood or bamboo
- Tying: rope
- The roofing is not water-proof and very weak. Quality of tarpaulin or polythene is low, the tying is not systematic, and due to the lack of available space, the roof is also used to store wood for drying.
- Termites' attacks are frequent and durability of wood and bamboo elements is short.

Fences

Structure: wooden structure screwed to RC pillars
2 main compositions of fence:

- Composite façade:
    - CGI sheet for base of the fence (2'6'')
    - Bamboo mat (6')
    - Bamboo grid (1') on top of wall
- Solid CGI fence between shelters

NB: CGI is quickly damaged at the interface with ground.

Bamboo mat is not waterproof: doubled inside with tarpaulin.

top :
Main structure, RRC posts + wooden posts
Left:
storage platform

«Garenja» window & ventialion
inner cooking place and mud palsters for fire protection

Walls

▪ Many extensions are built in mud masonry : 5’ to 6’ height walls 1’ thick at the base (and thinner on top)-or half walls- constitute the structure.

▪ The mud walls are built piling 1’ high layers of local mud, plastered with mud after the complete drying of the massive walls.

▪ Half walls are completed with light fence on the upper part: *tati* fence (wattle and daub) or bamboo mat, or CGI sheets.

▪ Insertions (wood or brick insertions) are placed in the massive wall and used to hook the structure via GI wire or PP straps.

▪ Mud walls built as a second “shell” around the CGI fenced shelter provide protection of the central shelter (rain and thermal barrier).

▪ Partition walls are also built using mud masonry combined with light fences and bamboo structure.

▪ Households plaster the mud walls with cement plaster if they can afford it.

Joints

▪ Wood structure is nailed / screwed to RCC posts.

▪ Bamboo elements are tied with rope to the wood purlins.

▪ Fences are nailed to wood secondary structure and tied to bamboos.

Openings

▪ The main openings used for ventilation are bamboo grids on the upper part of the fence (1’ high).

▪ Windows are 2’-6’’x6’-6’’and 3’x6’-6’’, with wood structure and plan sheet.

▪ Extra windows are placed in the fence, at 1’ or 2’ from the floor (providing cross ventilation and corresponding to people sitting. Horizontal bamboo grid (for instance 1’’x4’’).

▪ This ventilation creates weaknesses (no rainwater protection) in the bamboo fence, so it is completed by a removable tarpaulin / polythene on the outer face.

Special provisions

▪ Cooking stoves are inside the house, but have no smoke pipe. It is a source of disturbance for the inhabitants and for the neighbours. The partition wall (CGI fence) between 2 shelters in a raw is not “smoke proof” and the bamboo fences are not fire resistant. The risk for fire propagation is high.

▪ In some cases the walls around the stoves are protected with mud walls or at least with mud plaster.

▪ Many makeshift hanging shelves and storage mezzanine are developed.

▪ Mud platforms (sleeping place, but also raised place to store the more fragile items in case of heavy rains).

5.4 Building process

Which are the criteria to choose: house position, house materials, artisans

Construction season and why

November to December (dry season)

Duration of construction

▪ 10 days for a shelter (light structure covered with tarpaulin).

▪ 2 months for mud masonry

Construction steps

After the construction of the basic shelter by UNHCR, households have added rooms and verandas, step by step (when affordable)

Top:
Roof maintenance is the major problem for households
Left :
CGI fence needs frequent replacement and fixinggs
Right:
Pest attack on bamboo rafters

Who does what?

▪ UNHCR was decision maker in the construction process.

▪ Households extended and or improved their shelter.

▪ Households don't receive any external technical assistance, but share experiences with the neighbours.

5.5 Maintenance

Average lifespan of each construction type

After 26 years, most of the shelters are still standing, but many components have been replaced. Using the same material or any cheaper / more durable materials (if allowed).

Average lifespan of the materials according to the construction part for which they are used

Parts that need maintenance (main problems and reasons)

▪ The tarpaulin tends to accumulate water, then water is dripping inside. Fast decay because of UV, and mechanical stresses.

▪ CGI bottom part is rusting.

▪ Wood and bamboo are attacked by termites

What has to be done?

▪ The roof is completely dismounted and rebuilt several times a year, and need to be clean from stagnant water, re-stretched and tied. Changed after high winds (torn or blown away).

▪ CGI fence is changed or replaced by bamboo mats or mud walls.

▪ Plasters on mud walls: mud plaster has to be applied every year. Some households prefer to finish the external face with cement plaster, or cover the wall with polythene.

Who does it?

Householders do the maintenance works.

Frequency

▪ Roof :

▪ The roof (tarpaulin + secondary structure) is the weakest point. It needs to be changed 1 or 2 times per year

▪ Plinth :

▪ Plinth is maintained frequently, about twice a month.

▪ Flooring :

▪ The floor, mud floor in most of the shelters, needs weekly maintenance. Mud plaster applied 1-2 time / week by women.

▪ PP floor mats are used to cover the mud floor when sitting / sleeping. Easy to clean, remove.

CONSTRUCTION PART	FREQUENCY
FOUNDATION / PLINTH	Twice in a month
PILLARS	N/A
FENCE	Regular
CEILING	Yearly
ROOFING	Once in two year
MUD WALLS	20 years

5.6 Building materials

BUILDING MATERIAL	AVAILABLE ON LOCAL MARKET	CHARACTERISTICS / REMARKS
WOOD	Yes	Untreated, termite attacks
BAMBOO	Yes	Untreated, termite attacks
STONE	No	/
MUD	Yes	Locally available, but not always directly on the plot
THATCH	No	
TARPAULIN	Yes	Polythene is more accessible, mostly used
CGI	Yes	Not allowed for shelter roofing
NAILS	Yes	/
ROPE	Yes	Low quality observed (1/4'' PP strap)
WIRE	Yes	/

5.7 Skills for construction

Number and types of available artisans in the area

▪ Masons, carpenters, artisans skilled in bamboo works are available in the camp. No data on the number, most of them have not received any formal training nor a certificate of competence due to the situation. Unemployment is a key issue.

5.8 Construction costs

Materials and labour costs

NB: For material prices see in 3.7

	DAILY WAGE
MASONS	800-1500
CARPENTERS	800-1500
LABOURERS	500

Most expensive part of the shelter

▪ According to the interviewed people, the most expensive part is the fence

▪ Roof: with an estimate cost of 3'000 to 4'000 BDT per year (total cost in the past 26 years = 78'000 to 104'000 BDT).

Average costs of existing shelters

No data.

5.9. Natural hazard and Coping strategies

Collective measures for vulnerability reduction

How do you get early warning of disaster?
- Signal by UNHCR

What are the arrangements to improve resistance of the shelter?
- Tightened with rope

What do people do before, during and after a disaster?
- Prepared with food and documents.

Where do people take shelter during disasters?
- Community centre

What are the main difficulties people are facing after a disaster?
- Shelter, food.

What are people's priorities? Is it more important to protect their belongings? Food? NFI?
- Food and NFI.

Or to preserve the shelter? In this case which part of the shelter is considered more valuable?
- Roof

5.10 Findings

After 26 years, the housing situation in the registered camps are still very basic. People are suffering from the lack of space, low indoor comfort, expensive maintenance constraints. They have to deal with a general site plan that doesn't offer many opportunities of improvement : clustered shelters, narrow paths, few public spaces or green areas.

The roof constitutes the main bargain

As a response people extend their shelter by themselves, with their means and skills. The panoply of solutions developed for the extensions and partitions is of great interest. It might give us an idea of the future transformation that can be imagined in the new camps by the FDMC.

Top:
Sofiulah Katak host community, hill cuts on hills after new arrivals deplacement
Left:
Shelter / houses typologies:
Mud wall house
Bamboo & tarpaulin shelter
CGI fences & thatched roofed house

6. Host communities: local building culture assessment

This chapter focuses on the building practices of host community, living in the adjacent area of the camps.

General information

Population:

- Population of host communities in Cox's Bazar District: 2 300 000 persons [20]
- Population in Teknaf and Ukhia Upazilas: 500 000 persons
- Average family size: 4-5 persons
- Religion: Muslim 89.1% / Hindu 10%/ Other 0.9% (includes Buddhist, Christian)[21]
- Income: 33% of the people are estimated to live below the poverty line

Infrastructure

- Local authorities claim a severe lack of community facilities. The main difficulty being:
- Insufficient number of primary schools[22] ;
- Need for water, sanitation and hygiene (WASH) facilities;

Main activities

- Lack of working opportunities, high unemployment level (increased by labour competition induced by new arrivals)
- Main livelihood activities: daily labour, farming, petty trade but also fishing (proximity to sea).
- Need for better access to food (food production is low), rising prices on market.

Complementary information

CPP (cyclone preparedness program) training is being conducted with up to 300 volunteers, conducted by DMC (Disaster Management Committee).

- Site

Morphology

- Hilly region, alluvial lands between the Bay of Bengal and Naf River (border with Myanmar)

Access

- Most of the shelters / houses are not directly accessible by the roads.

Location of shelters/villages and use of land nearby

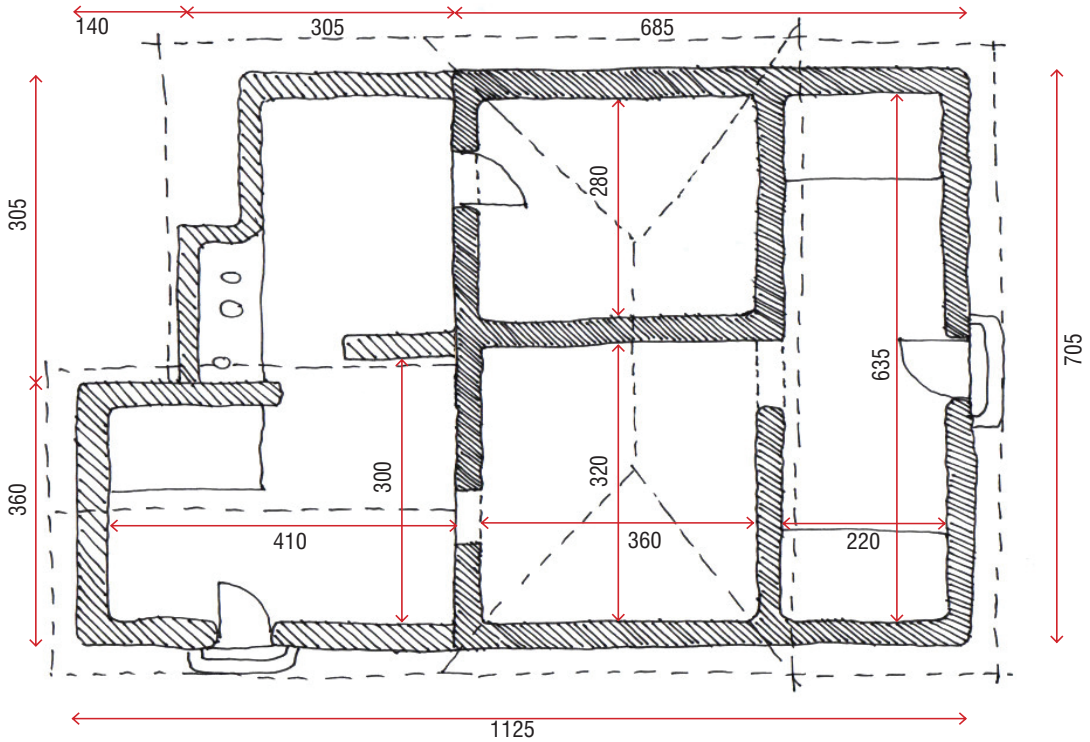
- The plots used for housing are in huge majority located on hills, the lower and flat lands being used for agriculture. Hills are covered with trees.
- Main land owner is the Government of Bangladesh

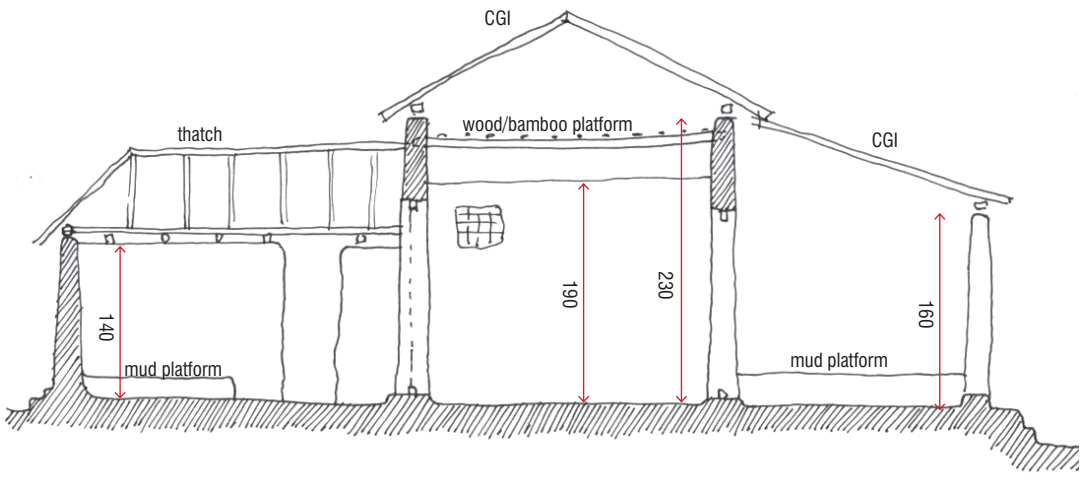
---

20 The 7 *Upazilas* comprising Cox's Bazar District have a total population of 2,290,000. It is one of Bangladesh's most vulnerable Districts. Malnutrition, health status and food insecurity are at crisis levels, and the poverty rate is well above Bangladesh's national average. Even before the influx, one in five households already had poor and borderline food consumption patterns – which was much higher than the national average. On average, 33% live below the poverty line and 17% below the extreme poverty line. In JRP

21 National %

22 The primary school completion rate for Cox's Bazar is 54%, while the divisional and country level rate is about 80%. In JRP


140
305
685
305
280
635
705
360
300
320
410
360
220
1125


CGI
thatch
wood/bamboo platform
CGI
140
mud platform
190
230
160
mud platform

6.1 Shelter typologies

Main types of existing shelters in the area:

▪ Temporary shelters with CGI fence and roof and bamboo / wood frame.

▪ *Juphri* shelters, structures made of a bamboo frame covered in plastic sheeting. These shelters are similar to emergency shelters[23].

▪ *Kutcha* houses (mud masonry walls).

▪ We chose to focus on the description of the *kutcha* houses, as they represent the main housing typology in the surveyed areas.

Description of kutcha houses

Shape and size, orientation, space arrangement, particular elements

▪ Regular rectangle or square shaped buildings

▪ 70 to 90 m2

▪ Orientation is given by the plot (cut in the hill), the main façade opposite to major winds.

▪ Consist in a central part (room) surrounded by a large corridor used for many activities from cooking to storage or sleeping platforms. The lower roof is very low (>150 cm) which provides an aerodynamic shape to the general volume.

Additional buildings

▪ Facilities in the courtyard: extra cooking place, cattle shelter, bathroom

Comfort

▪ The massive walls, combined with cross ventilation provide a tempered indoor climate.

▪ The central room or rooms benefit from more privacy than the peripheral spaces.

▪ Indoor spaces are dark, because windows are small and rare.

▪ Indoor cooking space might disturb the inhabitants (though most of the houses are equipped with *bondu chula* (environment friendly stoves), including smoke pipe

6.2 House structure

Foundations/plinth

▪ Foundations are made out of mud mortar.

▪ The house sets on a 1’ to 1’6’’ mud plinth.

▪ Plinth as a sacrificial surrounding layer with several steps, corresponding to the different flood level risk.

23 NB: in the district, housing also includes *Pucca* houses (brick and concrete foundation) but almost exclusively in urban contexts. Considering the non-acceptance of the GoB for concrete frame and brick masonry structures in the camps (including 25 year old registered camps, except for communal facilities like schools or mosques), we focused on the other typologies.

previous pages
House assessed in host community (Sofiulah Katah)
Plan & section of the house

Main structure

Massive mud walls (1' to 1'6'' at the base, thinner on top according to the height of the wall).
Stability of the wall is obtained thanks to:

- The shape of the house : compact, squared or rectangle with small ration L/l.
- Symmetrical shape of the house.
- Thickness and shape of the walls: if the peripheral wall of the house is not continuous, each monolithic element is "L" or "U" shaped.
- Timber beams on upper part of the higher wall increase the resistance of the wall in case of earthquakes.

Roof

Roof is divided in two independent parts, or even more:

- 4 pitched roof for the central part.
- 4 pitched roof for the "corridor".
- + An extra 2 or 4 pitched roof for the kitchen.

Roof structure: wood purlins and bamboo +wood rafters.

Roofing materials: CGI for the central part.

Joints

Wooden joints are using nails, but also metal straps
Overlapping of ring beam is not very strong (diagonal cut + nails)
Bamboo /wood joints are made out of rope of PP strap

Roof structure is tied to a wooden insertions placed 1'' to 2'' from the top of the wall (tied with wire or PP strap). The roof is hooked to the heavy walls.

Openings

- Open space between roofing and walls.
- Small windows(1'6''x1'6''), 1 per façade, 2' to 2'6'' from the floor, wooden shutter.
- Doors and windows are placed to create cross ventilation in each room.

Special provisions

- Mud platforms.
- Mezzanine storage.
- Wind / storm protection from hill and trees.

previous pages
top :
Inside typical house in host community (Sofuiulah Katah) :
massive mud walls , mud plateform, thatch roof, cross ventilation and top of the wall ventilation.
Middle:
Massiv walls with minimum openings
4 pitched roofs with
Bottom:
Inside corridor used for sleeping and cooking activities

6.3 Building process

Criteria to choose: house position, house materials, artisans

Before starting the construction, the house position and distribution is discussed in a village committee formed by neighbours and local artisans.

Local artisans are in charge of the construction. Artisans receive an onsite training (no formal training in most cases). They use to share and discuss the technical issues though there is no formal artisan group identified.

Choice of materials depends on the means of the Householders.

Construction season and why

January to April is the most appropriate season for most construction works (dry season)

Duration of construction

The construction of a 12m x 8m house built out of mud walls takes 30 day to 3 months

Construction steps

The construction is incremental, so rooms are added according to the means and needs of the householders. In the observed cases, a central part (2 rooms) is surrounded by a closed "corridor" for rooms, kitchen, storage,etc.

Who does what?

Decision maker in the construction process are the households members.
Local artisans are in charge of the construction.

Ways to reduce construction costs

Households members are involved in the construction of the shelters: participate in construction works, maintenance, materials carrying, etc.
They receive technical help from the neighbours.

6.4 Maintenance

Average lifespan of the materials according to the construction part for which they are used

CONSTRUCTION PART	FREQUENCY
FOUNDATION / PLINTH	Twice in a month
PILLARS	N/A
FENCE	Regular
CEILING	Yearly
ROOFING	Once every two years
MUD WALLS	20 years

previous page
Inside veiws :
Mud flooring and mud plasters.
Wooden structure reinforcing the mud walls, and used as support for storgae mezzanine
oustside views:
Mud wall on platform, plastered with mud. Steps on the plinth respond to the different flooding risks
Drainage and local protection of mud wall with plastic sheet

Top:
4 pitched thatched roof covered with plastic sheet
Left:
4 pitched roof covered with CGI
Local salt storage covered with thatch
Maintenance of mud platform

Parts that need maintenance (main problems and reasons)

- Mud plinth needs frequent maintenance. Twice a month.
- Mud walls are re-plastered with mud mortar (white or light colour clay when available), if possible before monsoon (or at the start of monsoon because of water scarcity).

NB: Some householders prefer to use polythene to "protect" the most exposed walls and plinths. This should be done only punctually (risk of humidity raising in the wall)

- Thatch roofs: need to replace the roofing material, possibly every 3-4 years.

NB: some people protect the palms or grass with polythene (for longer lasting according to the users)

6.5 Building materials

BUILDING MATERIAL	AVAILABLE ON LOCAL MARKET
WOOD	Yes
BAMBOO	Yes
STONE	No
MUD	Yes
THATCH	Yes (*Chone*)
TARPAULIN	Yes
CGI	Yes
NAILS	Yes
ROPE	Yes
WIRE	Yes

For prices of the materials see 3.7

Thatch: grasses and leaves are used for thatching in the region:

- Grass:

Chone / vetiver (*Binna Ghas*) / *lamba Ghas* / *Kasua Ghas*

- Palms

Beetle nut (*Shupari pata) / Coconut (Narikel Pata)*

6.6 Skills for construction

Skilled masons are available locally for mud masonry and wood /bamboo carpentry, thatch or CGI roofing. Most of them have an informal training, so there is no register of the skilled artisans. Artisans have onsite trainings with more experimented ones, exchange on the main issues in construction works is a common practice between artisans of one area.
Women are involved in plastering, flooring and maintenance.
Unskilled works are done by labourers and/or inhabitants and relatives.

6.7 Construction costs

Materials and labour costs

	DAILY WAGE (BDT)
MASONS	1,500
CARPENTERS	1,500
LABOURERS	800

CONSTRUCTION PART	DURATION	COST (BDT)
FOUNDATION / PLINTH	10 years	2,500 to 3,000
PILLARS	10 years	Each 600-800
FENCE	4-5 years	40,000
CEILING	5 years	10,000
ROOFING	2 years	5,000
MUD WALLS	20 years	40,000

Most expensive part of the shelter

According to the interviewed people inhabitants and artisans, for mid-term to longer term (20 years for instance) shelters, the most expensive parts are the roof and fences, which need frequent replacement.

Average costs of existing shelters

Estimated cost for a 26'x40' house: 150 000 BDT -200 000 BDT (= 145 BDT/sqft to 190 BDT/sqft)

6.8 Main damages during disasters

BUILDING COMPONENT	TYPE OF DAMAGE	LEVEL OF DAMAGE (HIGH /MEDIUM / LOW)	REPAIRED?	REBUILT?
DRAINAGE	Earthen drain	Medium	Yes	/
FOUNDATION / PLINTH	Earthen	Medium	Yes	/
PILLAR	N/A	N/A		/
WALL / FENCE	Broken	Medium	Yes	/
TRUSS	Flied away	High	Yes	/
ROOFING	*ditto*	High	Yes	/

6.9 Natural hazards and coping strategies

Main features:

What kind of disasters generally occur?

- Cyclone

With which frequency (ordinary and exceptional disasters)? And during which season? ¨

- April, May

What disasters cause the more damages?

- Cyclone (especially 1994 cyclone)

After how much time does the situation go back to normality?

- 1.5-2 years

What is the most exposed?

- Houses and trees

Collective measures for vulnerability reduction

What are the arrangements to improve resistance of the shelter?

- Low height walls with heavy roofing

What do people do before, during and after a disaster?

- Before, they get prepared to take shelter, with stocks of food and their documents. During the disaster, they stay in the shelter.

Where do people take shelter during disasters?

- Local *Masjid*, school.

What are the main difficulties people are facing after a disaster?

- Food and sheltering.

Situation after a disaster

What are the available materials in the area?

- Bamboo, wood, rope etc.

Are materials from destructed shelter available for reemployment / recycling?

- Bamboo, RCC post

6.10 Findings

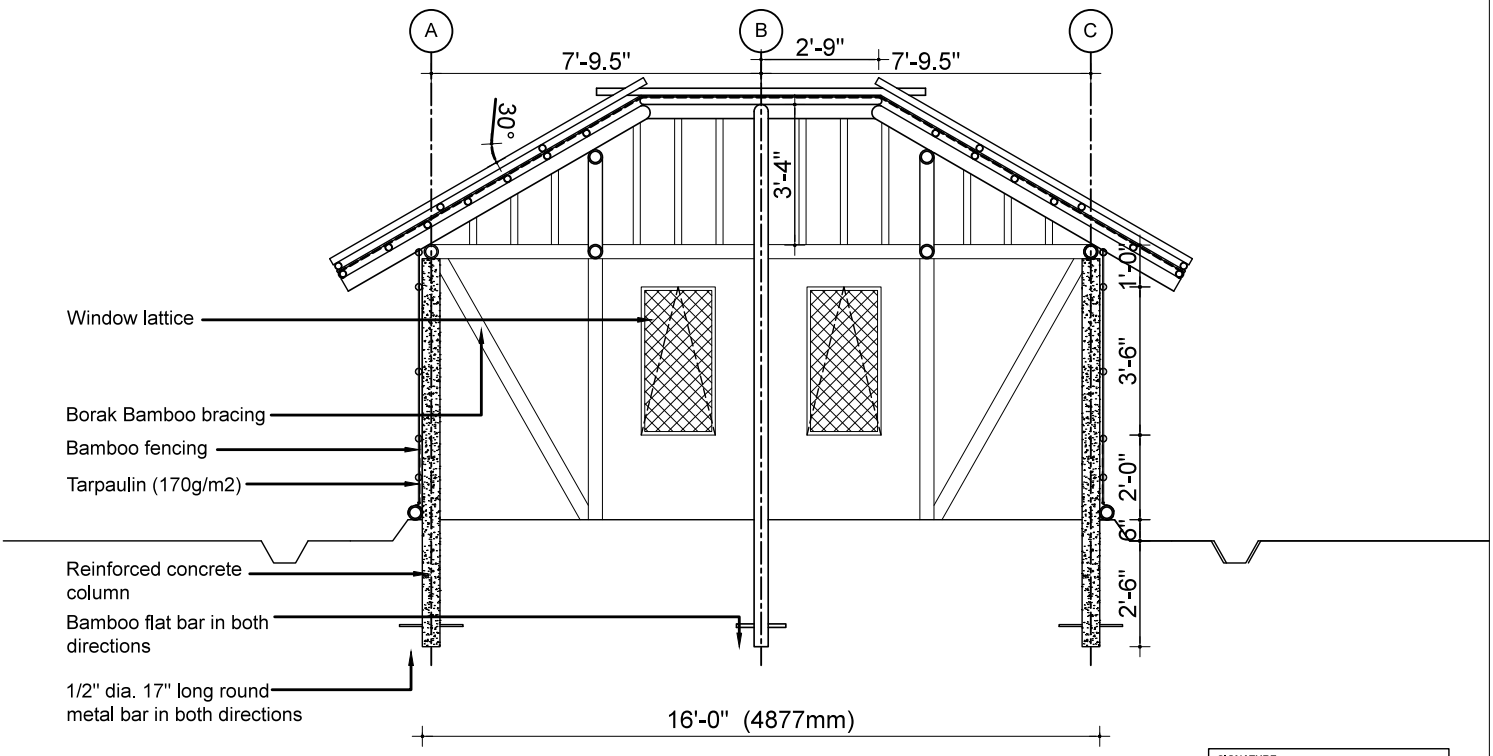
The local building culture in the host community in Ukhia and Teknaf is rich and offers interesting solutions for this hazard prone area, where population have low incomes. Cheap and safe solutions can be observed
With their informal and efficient organisation, people build intelligent houses made out of mud masonry and bamboo or wood structures (for roofing)

As a response to the scarcity of space and materials, people have developed homemade furniture and storage solutions, which could be introduced in the shelter design: bamboo "*macha*", mud platform, mezzanine for storages etc.

Still there is a huge need to provide assistance to the more vulnerable, and a need to develop community facilities.

next page
top :
section of Midterm shelter option 2
bottom :
front elevation of Midterm shelter option 2

OPTION 2

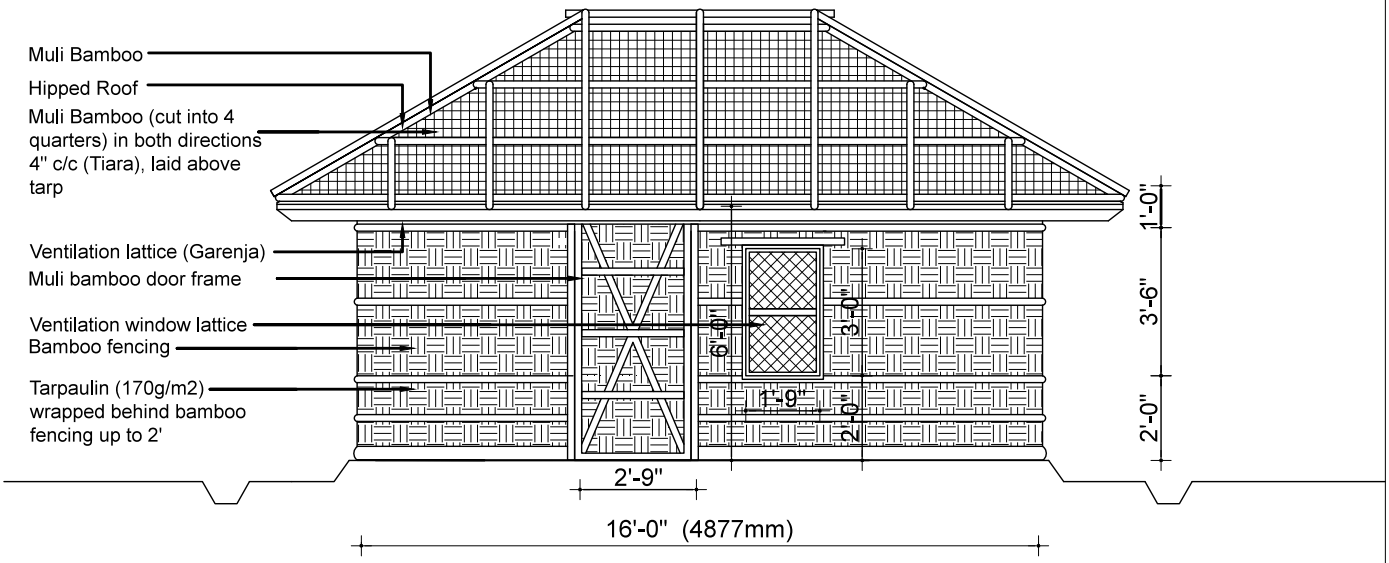


SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY: CARITAS BANGLADESH / CRS RECOMMENDED BY: SHELTER AND NFI SECTOR	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR For Construction: MAY, 2018	PAGE TITLE: SECTION B DWG NUMBER: SH-04 SCALE: 1:40 @ A4	PREPARED BY: JH NOTED BY:	APPROVED BY: RRRC	A SHEET NO: 4 7

OPTION 2



SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY: CARITAS BANGLADESH / CRS RECOMMENDED BY: SHELTER AND NFI SECTOR	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR For Construction: MAY, 2018	PAGE TITLE: FRONT ELEVATION DWG NUMBER: SH-05 SCALE: 1:40 @ A4	PREPARED BY: JH NOTED BY:	APPROVED BY: RRRC	A SHEET NO: 5 7

7. Mid-term shelter models

The main objective of this chapter is to design cost effective, more disaster resilient and durable shelter models after providing emergency shelters and upgraded shelters to the registered camp sites. These shelters are mentioned as mid-term shelters. This chapter describes about principles, shelter types, building materials and relevant information about mid-term shelter models.

7.1 Context

- Needs: 207 000 households (approximately 1 000 000 persons).
- According to the coordinator[24], it is realistic that it will take **3 years** to cover the need for mid-term shelters.
- The implementation would start after monsoon.
- The idea is to cover 50 000 persons by December (5% of 1 000 000 FDMC).
- Designed by the Technical Working Group for Mid-term Shelter.
- Recommended by the Shelter and NFI Sector.
- Caritas Bangladesh and CRS are developing 5 prototypes from which 1 should be chosen for large scale implementation.

7.2 General principles[25]

- Aspire to meet relevant standards – Government / SPHERE.
- Minimum 190 sqft floor area (for 5 members' families).
- Benefit both local economy and host communities.
- Household led construction approach.
- Access and design for disability.
- Provide privacy.
- Be cost-effective.
- Design flexibility to meet site conditions.
- Be appropriate to climate and weather.
- Promote cross ventilation.
- Minimize environmental impact.
- Provide sufficient durability for the mid–term.
- Can be easily repaired and improved.
- Can be upgraded in phases.

7.3 Shelter typologies

In this study we focus on the shelter prototypes from Caritas Bangladesh and CRS : 5 designs have been developed and 10 prototypes were built on site, in order to test different solutions, including 1 double shelter and 2 shelters with footings.

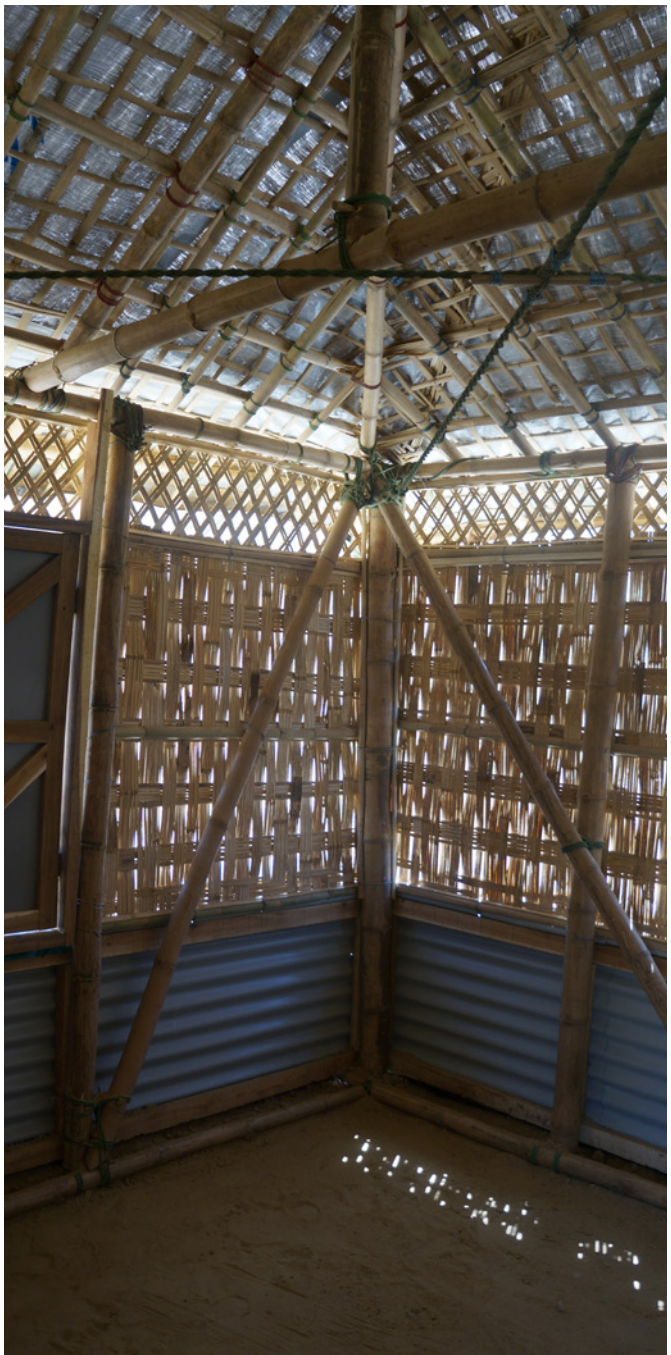
Type	Length	Width	Height	Rooms	Surface (sqft)	Surface (m2 /person)
1	18'	10'6''	7'	2	189	3.5
2	16	12'	7'	2	192	3.6
2b*	31'7''	12'	7'	4	380	3.6
3	14'	14	7'	2	196	3.6
4	18'	10'6''	7'	2	189	3.5
5	15'	10'	7'	2	150	3.5

The dimensions of the shelters above are reduced due to the land crisis and the maximum cost fixed by RRRC, but respect the minimum floor area / person proposed by the Sphere humanitarian standard.

*2b: 2 shelters clustered

24 This has to be approved by the SAG -strategic advisory group

25 In Principles promoted by the Caritas in Mid-term shelter for Forcibly displaced citizens of Myanmar, 15.05.2018



Comfort

Indoor comfort is improved by the quality of the fences (non solid), cross ventilation (door/widows) and use of *garenja* on top of fences. The use of tarpaulin for roofing doesn't offer a good protection from sun radiation.

7.4 Shelter structure

Foundations/plinth

▪ Raised plinth and external drainage

▪ Foundations posts anchored to the ground

NB: Quality of the mud platform needs improvements. In further designs, mud platform has been consolidated with sand bags. Observed good practices in the host communities for this detail could be applied.

Main structure

▪ Precast concrete posts to main wall structure

▪ Cross-bracing fitted to the walls

▪ Bracing at ceiling level

Roof

▪ Hipped roof construction (4 pitched)

▪ Roof is secured with tie-down ropes

▪ Fence roof construction to fit tarpaulin

▪ Humanitarian grade tarpaulin for roof covering

Fences

▪ Lower part (2') : CGI or bamboo fence + tarpaulin or tarpaulin were trialed in the pilot construction.

▪ Bamboo fence (*Khara* Single *Tarja*)

▪ Upper part bamboo grid (*Garenja)*

Bamboo fence and tarpaulin solution has been selected in the final version because of :

▪ Cost: the CGI and timber battens option are more expensive and the final budget is limited by the RRRC

▪ Time: sheets take more time to be installed and tools to be cut

▪ Maintenance: bamboo fence and tarpaulin is easy to maintain/replace by the householders directly

▪ Timber availability: getting appropriate timber was a great challenge. The market is quite limited, cost is high and quality is relatively low.

Brick or mud plinths have also been trialed in the pilot phase.

Joints

▪ Dowelled and tied joints

▪ Strong connections between posts, walls, and roof

▪ All elements tied down

Openings

Each room is equipped with a door and/or windows on opposite faces to provide cross ventilation and natural light. Top of the wall *Garenja* offers complementary ventilation.

previous page
top : work in progress on shelter prototype construction:
placing the tarpaulin roofing on the bamboo grid (*Tiara*). Trial
of masonry plnth (not validated in the chosen design)
Bamboo trusses with dowelled and tied joints
Connection of bamboo structure with RCC post
Horizontal bracings with *borak* bamboo
Vertical bracing in the corners with *borak* bamboo.

UNHCR
UNHCR

7.5 Building materials

RCC

Providing gravel for the RCC post will be an issue to produce the RCC pillars. The local solution is to use crushed bricks as aggregates (NB: The use of crushed bricks as coarse aggregate decreases the compressive strength of concrete and the durability of steels, but in the case of RCC pillars for MTS it will not be a main issue).

Bamboo

The main problem is the durability of bamboos (see 5.8).

7.6 Skills for construction

Bamboo

The bamboo construction strategy responds to the specific skills of the beneficiaries. Most of the artisans and labours know how to build with bamboo. The restrictions in Myanmar have given them the opportunity to experiment this material (together with wood structures).
Training for the joints recommended will be needed.

RCC

RCC is not a usual technology for the FDMC. Local production of RCC pillar would need preliminary training.

7.7 Construction costs

Materials and labour costs

TYPE	DIMENSIONS	SURFACE (SQFT)	COST ESTIMATE (BDT)	COST OF MANPOWER (%)	COST ESTIMATE BDT/ SQFT
1	10’6’’ x 18’	189	87’500	36	463
2 DOUBLE	31’7’’x 12’	380	146’900	42	386
2 SINGLE	16’x12’	192	83’600	37	435
3	14’x14’	196	84’100	37	430
4	10’6’’ x 18’	189	87’500	36	463
5	15’x10’	150	80’100	39	534

NB : These prices are taken from the final design edited 15.05.2018,

Most expensive part of the shelter

- Structure and fences are the more expensive parts of the building
- RCC pillars represent 18-20% of the cost of the shelter, with long lifespan (>25 years)

previous page
top : different types of plinths trialed in the pilot phase
Garenja : 1’ bamboo grid placed on top of fence for ventilation
Bamboo fencing
RCC posts
tying of bamboo structure above tarpaulin roofing with roof structure
bamboo structure supporting the tarpaulin roofing (reinforced with inner tiara

Top:
Mid term shelter
Left:
Ventilation
brick masonry plinth trial
mud masonry plinth trial

Joints

- Dowelled and tied joints
- Strong connections between posts, walls and roof
- All elements tied down

Openings

Each room is equipped with a door and/or windows on opposite faces to provide cross ventilation and natural light. Top of the wall *Garenja* offers complementary ventilation.

7.8 Building materials

RCC

Providing gravel for the RCC post will be an issue to produce the RCC pillars. Local solution is to use crushed brick as aggregates (NB: The use of crushed bricks as coarse aggregate decreases the compressive strength of concrete and the durability of steels, but in the case of RCC pillars for MTS it will not be a main issue).

Bamboo

The main problem is the durability of bamboos (see 5.8).

7.9 Skills for construction

Bamboo

The bamboo construction strategy responds to the specific skills of the beneficiaries. Most of the artisans and labour know how to build with bamboo. The restrictions in Myanmar have given them the opportunity to experiment this material (altogether with wood structures).
Training for the joints recommended will be needed.

RCC

RCC is not a usual technology for the FDMC. Local production of RCC pillar would need preliminary training.

7.10 Construction costs

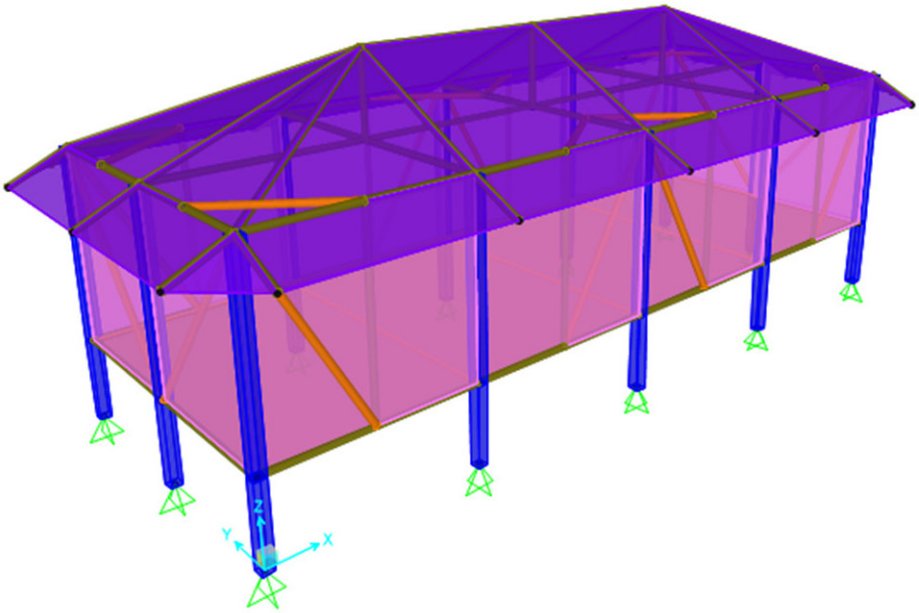
Materials and labour costs

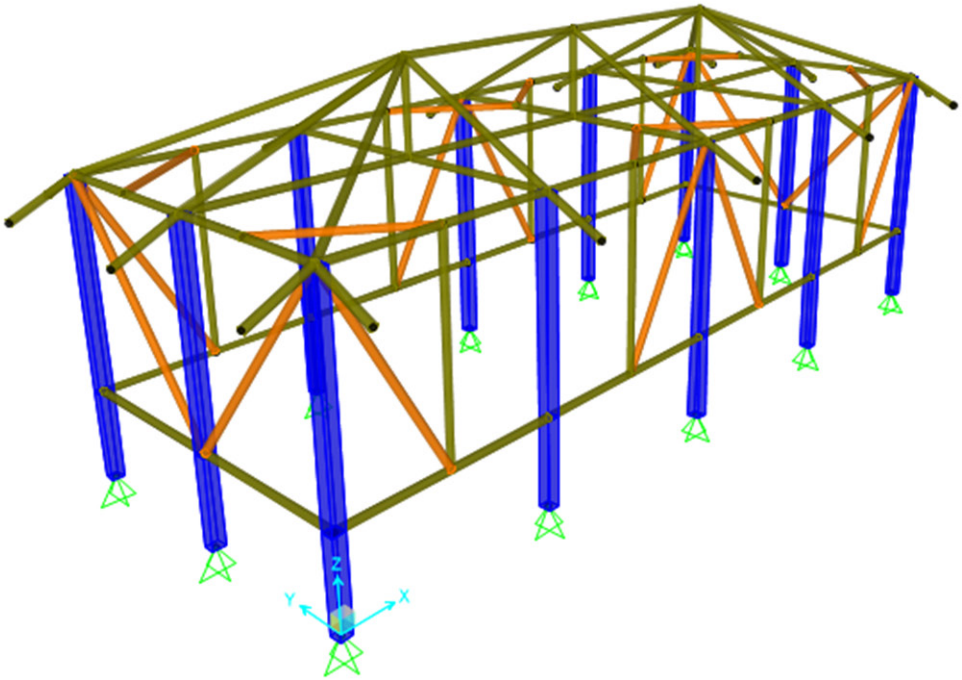
TYPE	DIMENSIONS	SURFACE (SQFT)	COST ESTIMATE (BDT)	COST OF MANPOWER (%)	COST ESTIMATE BDT/ SQFT
1	10’6’’ x 18’	189	87’500	36	463
2 DOUBLE	31’7’’x 12’	380	146’900	42	386
2 SINGLE	16’x12’	192	83’600	37	435
3	14’x14’	196	84’100	37	430
4	10’6’’ x 18’	189	87’500	36	463
5	15’x10’	150	80’100	39	534

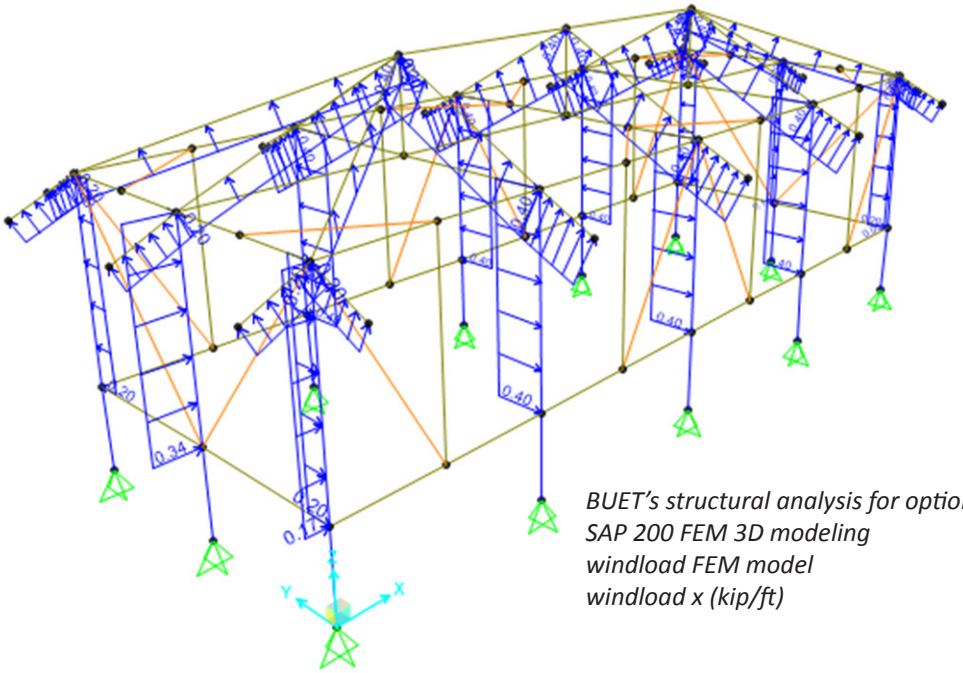
NB : These prices are taken from the final design edited 15.05.2018.

Most expensive part of the shelter

- Structure and fences are the more expensive parts of the building
- RCC pillars represent 18-20% of the cost of the shelter, with long lifespan (>25 years)
- Fence also represent 18-20% of the total cost, but with a shorter lifespan (1-3 years)







BUET's structural analysis for option 2 (2units) :
SAP 200 FEM 3D modeling
windload FEM model
windload x (kip/ft)

7.11 Findings

Reducing the number of materials and techniques : a coherent strategy

The strategy is to have a "unified" response based on the use of a reduced number of materiels : bamboo, RCC pillars, tarpaulin and ropes (+ mud platform).

The implemented strategy presents many advantages :

- Light materials (bamboo and tarpaulin)
- Skills available for bamboo construction
- Fast to implement (rope and pin connections mainly)
- Bamboo is available in the region / country[26]
- GoB acceptance

But there are still main issues to consider:

- Low quality control of the materials
- No treatment of bamboo / beneficiaries not aware of the treatment solutions
- Short lifespan of materials
- Low thermal comfort (mainly because of roofing solution adopted)

Findings from BUET's Structural analysis :

A structural analysis of the mid-term shelter option 2 (2 units) as been conducted by BUET's engineers[27]. The locations of the shelters is situated in the high cyclonic region and the wind speed as per BNBC 1993/2006 is 260 km/hour. However, this wind speed is valid for buildings and a reduced wind speed may be considered for non-engineered low-rise structures. It is important to consider the wind load while designing for mid-term shelters. Wind loading was simulated on SAP 2000 VER 15 structural software by BUET.
NB: If the shelter is on top of the hill, aerodynamic force needs to be considered which is 2-3 times of the normal force

Findings of the FEM Analyses

▪ For 260 km/hr wind load (as specified in BNBC, 1993/2006), Maximum uplift load at corner post= 11.5 kip and Maximum compression load at corner post= 7.5 kip.

▪ Considering, 150 km/hr target wind load:

Maximum uplift load at corner post= 11.5*(150/260)^2*2.5= 9.5 kip

Maximum compression load at corner post=7.5*(150/260)^2*2.5= 6.20 kip

(Here, the load is multiplied by 2.5 considering magnification at hill top).

Recommendations from final analyses

▪ Even though material properties are not specified or known at the stage of this analysis, it can be said that the super-structural members are adequate for the targeted loads. For proper evaluation of adequacy, material testing/full scale testing are needed. It is to be mentioned that for higher wind load (i.e., more than 150 km/hr), it is most likely that the roof and side walls may be blown away.

▪ However, open fences are safer and comfortable than the solid walls like CGI sheet/bamboo fence covered with tarpaulin. It is recommended to use part fence (e.g., lower part is CGI sheet and upper part is bamboo thatch).

▪ Proper foundation should be provided so that it can take the uplift force of 9.5 kip. Proposed foundation(s) capacity can be evaluated if the sub-soil properties are known. Or uplift test can be conducted to evaluate the uplift capacity.

▪ Concerns : Plastic ropes are prone to damage if exposed (UV)

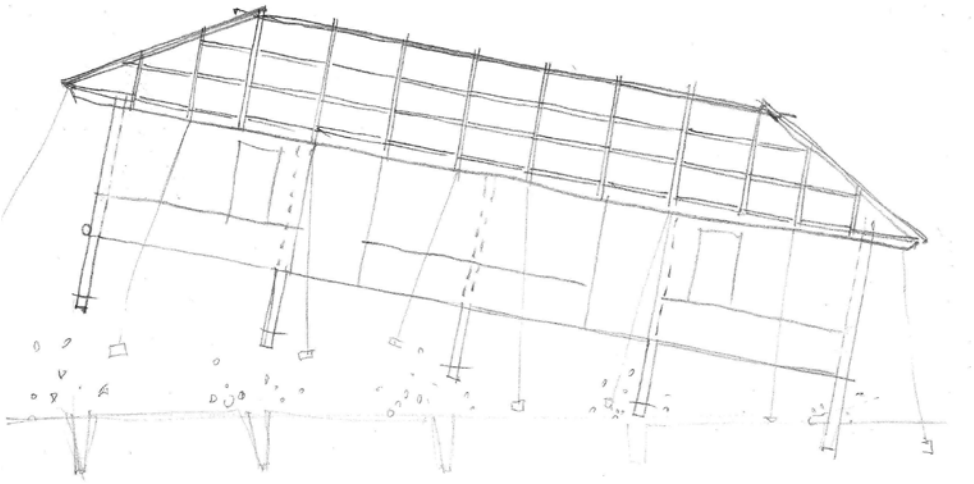
Extensions

No extension design has been developed and trialled so far. To avoid inappropriate practices that might not be compatible with the design of the shelter (mostly regarding its cyclone resistance and durability), it would be useful to foresee possible extensions and prepare the beneficiaries to good practices.

---

26 According to former studies, the need for bamboo for the mid-term shelters target would represent around 3% of the annual production of the country- Source IOM

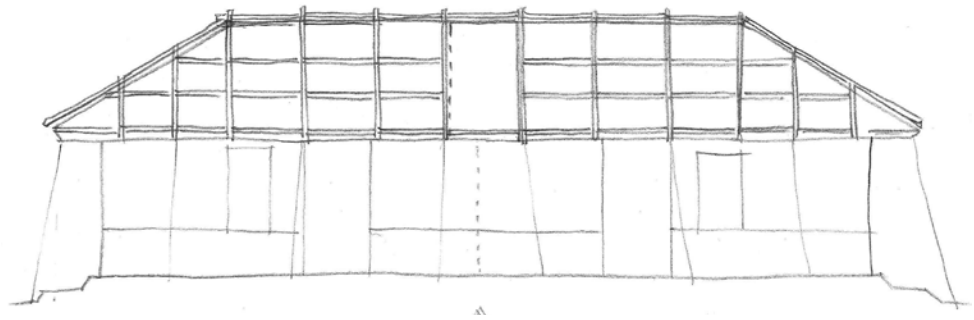
27 Study conducted by Prof. Dr M. Shariful Islam and Prof. Dr Tahsin R. Hossain, Department of Civil Engineering, BUET Dhaka, Bangladesh. For option 2 (2 units) design see annexes 9.3

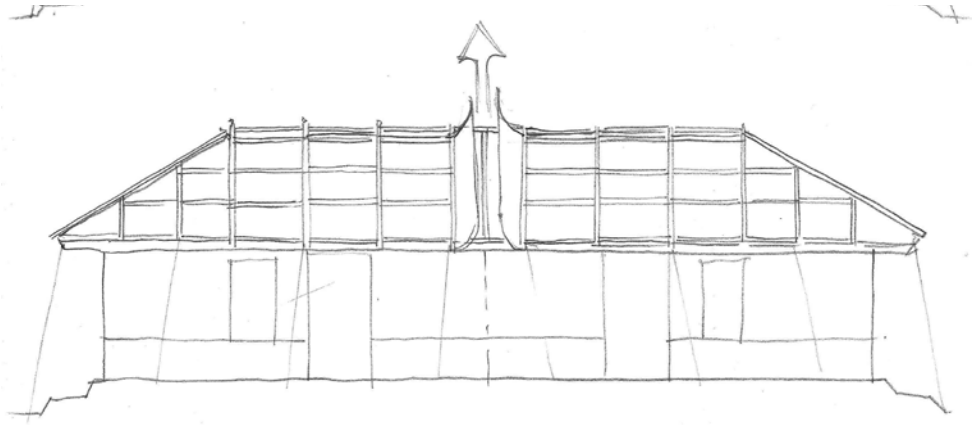


Option 1 :

the roof is built with a shelter grade one piece tarpaulin, and strongly tied.

Behaviour under extreme wind: the whole structure might be lifted up, which provokes severe damages.





Option 2:

The roof is built with a“weak point”: the roofing consist in 2 seperate tarpaulins with a large overlap , the bamboo grid mantaining the roofing is interrupted.

Behaviour under extreme wind:

at the “weak point”the tarpaulins get open, and release wind pressure. The roof is no longer water proof, but the damages on the shelter are less important.

8. Technical proposals

8.1 Use a "fuse element" in the roofing

The developed design introduces stronger ties and reinforcements of the tarpaulin roofing, which is a very important improvement for normal to strong winds..

Tarpaulin roofing could be considered as a solid surface.

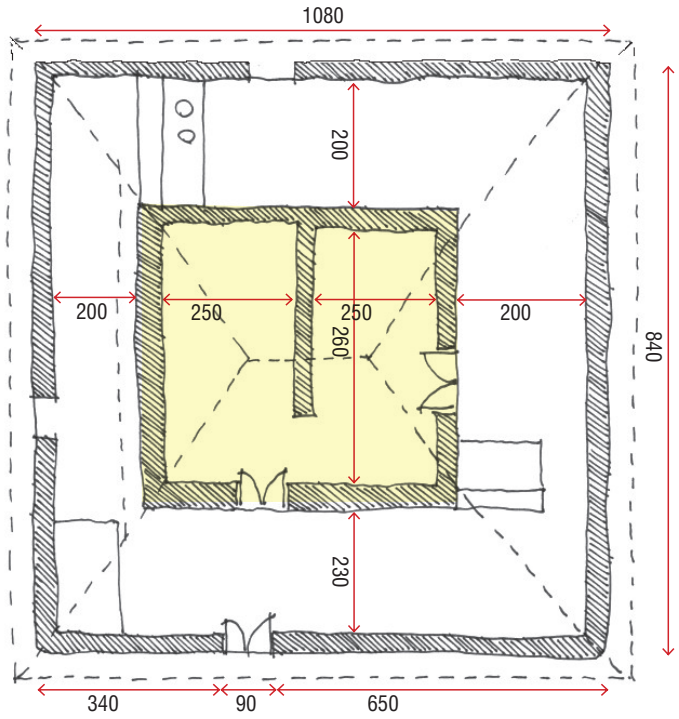
The structure is light and the foundations may not be sufficient to anchor the structure in case of a cyclone

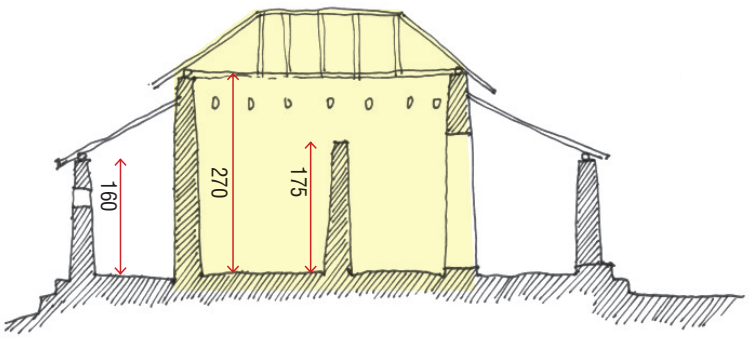
In order to avoid the complete uplifting of the shelter, a strategy is to create a fuse element. Different options could be considered and trialled:

1. By dividing the tarpaulin in 2 elements, using a waterproof connection (good overlap of the 2 elements) that would resist strong winds but would open mechanically (no need for the householders to intervene). The type of tying (rope resistance and type of node) could be sized

2. By using a waterproof but «non-solid» material. Thatch roofing would be a good option: light, not too harmful if blown away, fast to replace, green material. If it is not possible to build the complete roof (scarcity of the material, acceptance, etc.), at least a part of the roof could be covered with thatch.

Previous page :
Illustration of the "fuse strategy" applied to the shelter roofing


1080
200
200
250
250
200
260
840
230
340
90
650


160
270
175

8.2 Consider housing strategies developed by the population

Incremental development of houses

A developed strategy in the host communities is to build the house in different steps. First part or *ghar* is built with low initial investment, and then second part or «enclosed *pashchati*» is built when households can afford it, and/or when they need more space.

▪ At the beginning, a *ghar* can count 2 rooms, under a 4 pitched roof. Walls are tall enough to make possible future extensions (230-270 cm observed), but also mezzanine storage.

▪ Wall resistance is improved by wooden structure (joists) tying the top of opposite walls.

▪ After extension, the *ghar* is surrounded by the *pashchati* with*:*

▪ Lower walls (150-160 cm observed)

▪ Disconnected roof, but following the same slopes as the central roof

▪ Additional number of rooms (kitchen, storage, sleeping platforms, etc.)

▪ The 2 steps are complementary

▪ Pashchati provides protection from the heavy rains and winds, thermal protection to *ghar* (no direct sun radiations on the walls)

▪ *Ghar* can be used as a shelter if the *pashchati* is damaged.

▪ Aerodynamic general shape presents a good resistance to strong winds, regular squared shape is adapted to seismic risks

Extensions observed

In Kutupalong RC, the spontaneous practice of refugees is to extend the shelters using locally available materials : mud masonry walls is employed, sometimes combined with a wooden structure (step by step construction), or with light bamboo fence on top part (ventilated).

According to the inhabitants, mud masonry is the cheapest option although it is labour intensive: labour is widely available (mainly because work restriction for the refugees), and material is free. Other techniques induce material costs (CGI fence, Bamboo fence for instance).

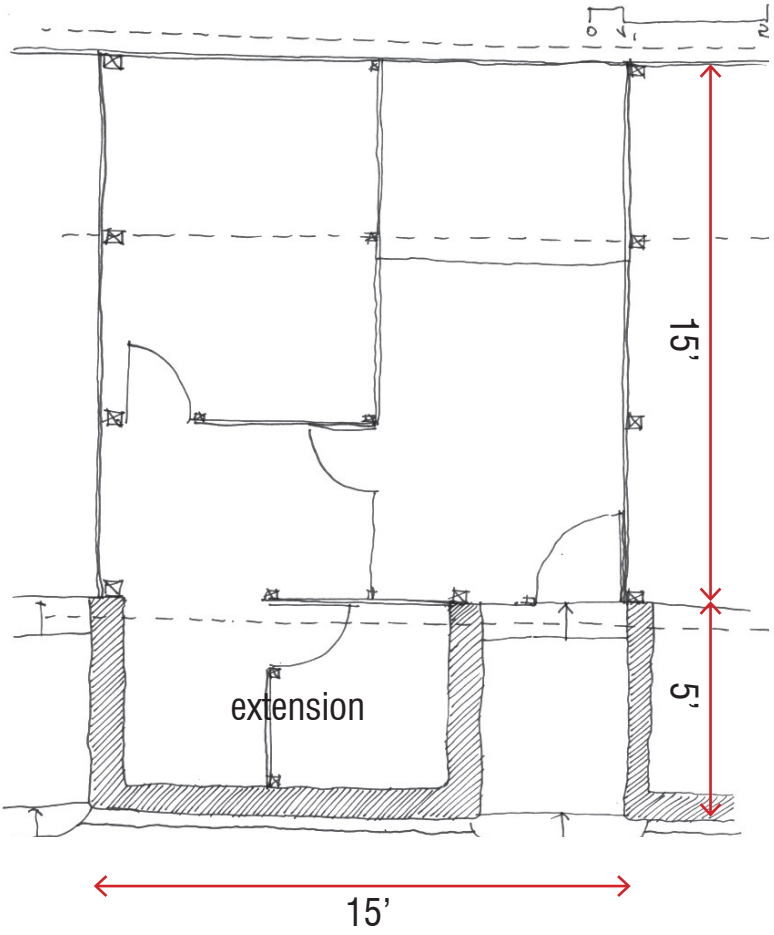
Types of extensions :

▪ Shelters in the middle of a cluster (raw of 6-8 shelters is the main pattern). Shelters are extended only on 1 side, on the entrance side. Footpath is occupied partially by the extension. The average width of such an extension is 5'by 10' or 15'. So the floor area is extended with one third of the initial area

▪ Shelter at the extremity of a cluster The initial shelter is extended in 2 or 3 directions. It is then surrounded by a 5' corridor, used in many different ways. The floor area can be doubled.

Previous page:
Top:
Extension of 30year old house, work in progress. Host community near Kutupalong camp

Exemple of house in Tengkhali host community, Ukhiya, built in 2 steps :
1. «Ghar» (yellow part
2. «peripheral corridor» or enclosed Pashchati»



Top + drawing : Extension of a shelter with a 5’ wide room. A U wall made out of piled mud provides space and protection of the inner part. the same pattern is repeated in the different shelters of the cluster (different techniques). Kutupalong registered camp.

Left: Enclosed Pashchati aroud a shelter. Bamboo frame and fencing used for the extension providing a ventilated space). Kutupalong registered camp.

next page : examples of extensions observed in Kutupalong registered camp : verandas, enclosed Pashchati, extra rooms

Refer to Low Cost House (LCH) design

Examples of LCH design and construction methods are a valuable source of information. Technical solutions implemented in similar contexts are available.

Considering the scale of the shelter response, it might be useful to provide different models adapted to the different sites conditions (the site characteristics are not homogeneous): plots uphills and downhill (flood prone areas.). Of course, many efforts are made to displace shelters from flood prone areas, but some plots might still be more exposed.

One option could be to combine a mud masonry half wall and a bamboo fence on top, which is a practice observed in the long term settlements (for instance Kutupalong RC). The risks that the complete structure would be blown away due to wind load on a light structure (bamboo fence and RCC+ bamboo posts) would be reduced in case of construction of or a heavy walls : 1' thick mud walls load approximately 500kg/m2.

The use of heavy materials (with high thermal inertia) for the external walls or parts of the wall would provide better indoor comfort.

NB: No matter what material is used for the walls, ventilated and"fuse parts" are still needed, in the roof for instance.

Related information

Housing and Building Research Institute (2018). Standard guideline for rural housing in disaster prone areas of Bangladesh. Housing and Building research Institute, Ministry of Housing and Public Works, Government of the Peoples's Republic of Bangladesh, Dhaka, Bangladesh.

Islam, M.S., Hossain T.R. (2016). Development of Sustainable Low-cost House Design and construction Method in Different Geographic Regions of Bangladesh. Bangladesh University of Engineering and Technology, Department of Civil Engineering, Bureau of Research Testing and Consultation.

Previous page, Top to botton :
Example of Low Cost House design : half mud wall for plinth & Ikor fence, Kanaighat
Example of Low Cost House design : half mud wall for plinth & Ikor fence plastered with mud, Kanaighat
Extension of refugee shelter : half mud wall for plinth & bamboo fence, Kutupalong RC
Extension of refugee shelter : half mud wall for plinth & bamboo fence, Kutupalong RC

Top :

Example of slope stabilizatoin with vetiver & Jute geotextyle , credit Islam MD.

Cut vetiver grass prepared for thatching

8.3 Work on slope protection with biotechnological measures

Bio-engineering method using local grass such as vetiver (binna grass) and geo-jute (JGT) may be used for slope protection at the camps. Proper design is needed by relevant experts for implementing bio-engineering technique at a particular site. Some details of this method are available in Islam, 2015 and Islam, 2016.

▪ Vetiver is available in most parts of Bangladesh. The available species is Vetiveria Zizanioides, which is the most suitable vetiver system for slope protection.

▪ Vetiver can grow in both silt and clay type of soils; also in saline soil and even in heavy metal contaminated soil. Vetiver is also effective in up taking heavy metals and salinity removal. It means that vetiver can be used for slope protection and land reclamation in Bangladesh.

▪ Direct in-situ shear tests and laboratory tests on reconstituted samples showed that vetiver roots enhance the shear strength and deformation capacity of soil significantly.

▪ Both the analytical and numerical analyses showed that vetiver plantation increases the safety of slopes. Vetiver root also enhances the bearing capacities of the ground.

It is urgent to conduct pilot studies on stabilizing slopes with vetiver. Although many trials have been conducted in Bangladesh for slope protection with vetiver, it is necessary to do a pilot study in the camps since the design varies with the soil type, slope, local climate, etc.

Of course a serious selection of plants, a plantation plan, and a training on plantation maintenance and use should be foreseen.

Planting vetiver on slopes would improve the local environment and be an opportunity to produce materials:

▪ Stabilized mud walls

▪ Thatch for roofing.

Participation of local population is the key element of its success. Training people about the other uses of vetiver would be necessary and could induce livelihood activities.

NB: On the most exposed parts mechanical slope stabilization should be implemented. On the new slopes of the SMEP, considering the future compaction of the soil and the differences between the new parts and unchanged parts, planting would not be sufficient to prevent risks of landslides.

Related information

Islam, MS (2015) Application of Vetiver (Vetiver Zizanioides) as a bio-technological slope protection measure-some success stories in Bangladesh. 6th International Conference on Vetiver.

Islam, MS (2016) Bio-engineering techniques using vetiver system for slope stabilization : River bank erosion perspective. Workshop on 'Mitigation of River Bank Erosion through Bio-engineering Techniques on Brahmahputra River in Assam Dispur, Guwahati.

Top to bottom :
Mud masonry walls : pilling up mud (2nd layer). Kutupalong
Mud masonry wallunder construction : 5th layer drying (plastic sheet protecting the top of the wallfrom rain). Tengkhali HC.
Mud wall exposed to main wind before maintenance. Sofiulah katah
Mud wall after maintenance: the main plalster is completed with a white clay plastre finish that provides better protection to sun radiations. Kutupalong

8.4 Complement the range of solutions with locally employed materials

As observed in the different locations of this study, other materials are used locally : mud masonry, thatch roofing being the more represented. Complementary materials would be useful for future improvements and/or extensions of the mid-term shelters.

Recommendations on mud masonry:

Mud is commonly used in the area for rural housing and in the camps. Like other materials it has its limitations and must be employed properly. As for bamboo construction, skilled craftsmen and local know-how are available. Mud works are labour intensive, which can be a limitation but also an opportunity in the camps

Main advantages of mud works :

- Fire resistant
- Available for free (cost = transportation)
- No toxicity, no treatment needed
- Easy decommission: removing the roof is sufficient
- Reversible : no waste on site after decommission (mud walls return to ground)

Piled mud masonry

Mud walls are erected in layers, openings for doors and windows are retained.

The soil is taken from the site or brought to site (if the quality of the available soil on site is not compatible with the technique) and prepared on site adding water to obtain a plastic mix, in some cases additives are added to improve the mud mortar: straw or rice-husk. After drying of the walls, the cracks are filled with mud mortar. Refilled cracks don't affect the resistance of the walls.

The surfaces of mud walls are then plastered with a layer of mud, sometimes mixed with cow dung, to achieve a smooth finish. The mud used for plastering is chosen for its characteristics, such as colour (white colour for sun reflection, etc.)

This plaster is regularly maintained especially before the rainy reason. The most exposed walls are plastered more frequently.

"Tati"construction (wattle and daub)

A wooden or reed or bamboo grid is covered with mud mortar. This allows to build thin mud walls, fast to implement. This building technique can be combined with massive mud walls. The lower part of the wall is thick and top part is thinner, which provides a better behaviour of the construction in case of earthquakes (low risk).

This technique can also be easily implemented for partition walls, it provides a good protection against fire between two rooms / shelters.

Plasters

Mud walls are finished with mud plasters or lime plasters. It is not recommended to plaster mud walls with cement plaster because it increases the dampness of walls, making them more vulnerable. Plasters should permit drying of the walls and vapour diffusion.

Mud plasters guarantee durability of mud masonry walls, and need maintenance.

Use local soil as much as possible

To avoid transports, it is recommended to use local soil for mud works. Local masons recognise different qualities of soils and know how to prepare them according to their qualities and limitations. For mud platforms, mud masonry half walls or low walls, there is no need to employ a "perfect"soil. It is possible to mix different available muds and/or add binders for better results. Local masons add for example the following additives:

- For reducing the shrinkage : adding fibres (rice straw or husk, vetiver grass, pine leaves, etc.)
- For making mud more resistant to erosion : mix mud with vetiver grass
- For reinforcing the mud walls : insert bamboo strips between the layers

For plasters, it might be necessary to select better quality soils to improve finishes. White clay is used for final coating, as it provides a better sun reflexion. The needed quantities for mud paints or final plasters are much lower than for main mud masonry works (platform of piled mud walls).

Protecting exposed mud walls from rain / wind erosion:

Different methods have been observed in the local building culture to reduce the effects of heavy rains on mud walls:

Thatch fence :
A thatch fence separated from the wall offers a good protection for the most exposed side of the house. A ventilated space between mud and thatch avoids humidity problems and improves indoor thermal comfort.

Cement plaster : this strategy is adopted in the registered camps. It provides a more resistant wall surface but is not durable : humidity is concentrated in the wall, which can cause plaster decay or even wall collapse. Lime plaster would be a more appropriate solution.

Plastic sheet
Polythene sheet used as a temporary protection can be observed in both camps and host communities. It has to be partial (only the most exposed part of the wall) and removed frequently to avoid humidity problems

"Protection hill"
The hill is cut to provide a protected platform from the main wind. Only the top of the house is exposed.

Related information

Many documents available on CRAterre website <http://craterre.org/diffusion>

Bee B. (1997). The cob builders handbook: you can hand-sculpt your own home. Murphy, OR : Groundworks. ISBN 978-0-9659082-0-7.

Evans I., Smiley L., Smith M., Michael G., BEDNAR D. (2004). The Hand-Sculpted House a Philosophical and Practical Guide to Building a Cob Cottage. White River Junction : Chelsea Green Publishing. ISBN 978-1-890132-34-7.

Weismann A., Bryce K., Main R. (2013). Building with cob: a step-by-step guide. Cambridge : Green Books. 252 p. ISBN 978-1-903998-72-4.

Previous page,
Top :
Stabilizing mud with fibers
Left:
reinforcing mud walls with bamboo strips between layers
Right:
Maintenance of mud plinth applying mud mortar regulary

Top:
Protection of most exposed mud wall using thatch on a light structure disconnected from the wall, Ashanushi.
Bottom:
House protected from the wind, Sofiulah Katah host community

Top:
Mud wall locally protected with plastic sheet, Mina Bazar host community
Bottom:
Recent cement plaster on mud walls, Kutupalong registered camp

Top :
Community kitchen implemented by Brac. Credit : Tarek mahmud
Local production of precast elements for Bondhu chula
Construction of Bondhu chula with the elements (bonded with clay)
Example of domestic Bondhu chula in use

8.5 Cooking facilities

Improved cooking stoves (ICS)

ICS could be implemented in the shelters to :

- Reduce health issues caused by repeated exposure to smoke[28]
- Reduce fire risks (fire and smokes are confined)
- Reduce fuel consumption

Bangladesh Council of Scientific and Industrial Research (BCSIR) has developed a ICS known as"Bondhu Chula", widely promoted in Bangladesh :

- Cost : approximately 800-1200 BDT for a domestic stove
- Estimate lifespan : 3-5 years
- Fixed stove type
- Regular maintenance is required, in particular cleaning of the chimney.

Mobile ICS could be an other option to limit the indoor smoke disturbance when climates allows to cook outside (veranda).

Community cooking spaces

Some ONGs (Brac for example) are implementing Community cooking spaces for approximately 12 - 15 families. This option would offer a valuable solution to the issues related to cooking inside the shelters:

The place is safer and offers appropriate cooking facilities using either gas or wood, but with ICS. It is easier to deliver fuel to the population as it is gathers

Considering the lack of space in the shelters, it would offer an opportunity to reduce the space allocated in the shelter to cooking activities, and offer an appropriate space for cooking : better ventilation, natural light, etc.

It would be an opportunity to develop social activities : a place where the cooker (almost exclusively women) can meet and talk while preparing the meal

Findings :

Precast elements for ICS could be produced locally, in local market or in the camps. The CC precast elements are bonded in the cooking space with mud.

Promotion of the use of ICS is conducted in host communities, so lesson learnt from the local experience are available and should be valorized.

Training and sensitizing should be the priority of such programs. Without proper training there is no chance that a change in cooking habits would be accepted by the households .

Community kitchens and domestic ICS are complementary. Community kitchens could be an opportunity to provide training and sensitizing on the use of alternative cooking solutions.

Related information

BRAC, (2006). Assessment of Existing Improved Cook Stove in Bangladesh. Retrieved from < http://cleancookstoves.org/resources_files/assessment-of-existing.pdf>

Global Alliance for clean cook stoves, (2012). Improved cooking stoves save lives. Retrieved from http://www.cleancookstoves.org/resources_files/improved-cooking-stoves-save-lives.pdf

Mahmud, T. (February 19 2018). Community kitchens: A place of sharing for Rohingya women" *Dhaka Tribune*.

28 The World Health Organisation has estimated that 46'000 women and children die each year in Bangladesh as a direct result of exposure to indoor air pollution, while millions more suffer from respiratory diseases, tuberculosis, asthma, cardiovascular disease, eye problems, and lung cancer 70% of the victims of indoor air pollution are children under five. In "Improved cooking stoves saves lives".

top
Example of 3 states of maturation of bamboo: young, mature and old Guadua bamboo (credits Guaduabamboo.com)
protection of bamboo mats by applying a protectoin coat, Kuataka
Left:
Air drying of bamboo culms, bamboos are standing on a footing, proteced from dirtect sun and rain
Storage of bamboo observed locally : bamboo s are stored on the ground, with no protection from sun nor rain.

8.6 Improve the lifespan of materials

Recommendations on bamboo selection, seasoning and treatment

The natural durability of bamboo is low and varies between 12 and 36 months depending on the species and climatic conditions. In tropical countries the bio-deterioration is very severe, bamboos are generally destroyed in about one to two years' time when used in the open and in contact with ground while a service life of two to five years can be expected from bamboo when used under cover and out of contact with ground. The mechanical strength of bamboo deteriorates rapidly with the onset of fungal decay in the sclerenchymatous fibres. Split bamboo is more rapidly destroyed than round bamboo. [29]

For improving the lifespan of bamboos the following parameters should be observed with care : selection of mature bamboo, proper harvesting period, drying process, and eventually treatment. Bamboo providers could be selected according to their capacity to assure the first parameters (selection,harvesting and drying).

Selection

Borak and *Muli* bamboo have been selected for the shelter response. Other bamboo species are growing in Bangladesh and could also be used (see BNBC 2015)

Choose mature bamboo:

3 to 6 years-old bamboos are recommended. There are few rules of thumb that help to roughly estimate the age of bamboo.

When the colour of the culm has changed from clear and shiny green to greyish green, and if the white bands at each node have almost disappeared and are replaced by almost imperceptible gray bands, the bamboo is mature.

If the bamboos are turning yellow they are too old.

When you strike a bamboo with a metal implement, the sound of older bamboos is louder than that of younger ones.

Harvesting

To understand why timing is so important, we just have to look at the composition of bamboo. Bamboo possesses large amounts of starch (sugars) which are the principle nutrients for parasites, borers and fungi. When carbohydrates are reduced, the bamboo culm will be more naturally resistant to those biological degrading organisms.

Sugar content in almost all plants varies with seasons. Dry season is the period of dormancy. During this period, the bamboo plant is acquiring and conserving nutrients for shoot growth in the next rainy season. Thus, starch content is at its highest level at the end of dry season! Therefore, harvesting bamboo at the end of a dry season increases the chances of borer and fungi attacks.

During the rain season, starch content is lower (since new shoots are consuming all the nutrients) but moisture content in the bamboo culms is high, which increases the possibility of subsequent splitting and cracking after harvest. This is also the period when new shoots emerge and felling operations could damage or destroy the shoots.

In other words the most recommended time to harvest bamboo is at the end of rain season - beginning of the dry season.[30]

After cutting the culms are posed upright supported by a tree, stones or nearby bamboo culms for two to three weeks. This will reduce the starch content of the culm, which will reduce the chances of insect damage.

Drying:

After the harvest, the drying process is the most important step in the new life of the bamboo cane. This is the phase where the bamboo canes reach their final shape: the poles should be stored horizontally with close supports so that they do not sag nor bend. Like timber, they should be protected from sun, rain and soil moisture.

With decrease of moisture content the strength of bamboo increases exponentially and bamboo has an intersection point (fibre saturation point) at around 25 percent moisture content depending upon the species. Matured culms should be seasoned to about 20 percent moisture content before use.

Air seasoning of split or half-round bamboo does not cause problems but fungal discolouration and decay should be avoided. However, rapid drying in the open sun can control decay due to fungal and insect attacks. Seasoning in round

29 In "Bangladesh National Building Code"
30 In "When-and-how-to-harvest-bamboo"

top
water treatment: bamboo culms are drawn in water.
bottom
Natural coating appled on bamboo mat

form presents considerable problem as regards mechanical degrade due to drying defects.

Non-chemical treatment

For the treatment of bamboos used in emergency shelters or mid-term shelters, non-chemical methods are recommended to avoid the risks of:

- Exposure of non skilled labourers during treatment process
- Contamination of soils and water, this is high risk considering the density of shelters and the poor water management in a emergency situation
- Poisoning with contaminated water induced

Non-chemical treatments are less expensive than chemical treatments and do not require technical skills nor tools.

NB: Non-chemical treatments are not destroying the decaying agents (for instance termites) but might increase the durability of the material. The existing population of xylophages on site is very important, this might be because of the huge quantities of untreated bamboo (and mostly immature bamboo) delivered during the formers phases.

A. Reducing starch content

Starch makes bamboo vulnerable to attacks by fungi and termites. Therefore, reducing starch content of bamboo is the best way to make it less vulnerable. You can reduce starch by:

Keeping culms in a standing position for a week after harvesting and for two weeks after transportation.

Harvesting only mature bamboos

B. Soaking

This should be done before drying the bamboo or immediately after harvesting.

When immersing round bamboo, nodes should be punctured before leaching. That way, water can easily run throughout the bamboo cane.

Bundle the bamboo culms or splits and store them in running water or tanks.

Use sinker loads for complete immersion.

Bamboo can be submerged for variable periods of time, after which they are extracted for their use or further chemical treatment. Without further treatment they should be immersed for at least 3-4 weeks.

An excessive time in water (more than three months) causes stains in the epidermis of the bamboo and has the consequence to decrease its physical and mechanical properties.

Take them out and keep them in the shade to dry them for at least one week.

Starch degradation in bamboo submerged under water is due to the activity of microbial populations in the water.

C. Smoking

This is a simple and effective method. A temporary smoking chamber can be built to smoke bamboo until they have a slightly dark colour. The heating of the canes to a temperature of 150 °C modifies the external structure of the bamboo, making it more resistant against insects' aggressions. This technique requires no chemical additions but raises two main problems: firstly, the poles can crack easily because of the variation of pressure within the bamboo and secondly, this heating process needs to be done under water (to prevent drying of the canes) and therefore requires a very big container and needs a lot of energy.

D. Mud curing

A method of mud curing is practiced in which freshly cut culms are soaked in muddy pond for 1-8 weeks and then slowly dried in the shade (Choudhury, 1993).

Top :
Protection of bamboo fence, on most exposed part, Kuatala
Bottom:
Drilling holes in the bamboo culms facilitate the treatment
(photo: Chiangmai Life Construction)

Chemical Treatment

For making bamboo durable, chemical treatment could also be chosen, but only if a strict control of treatment process and construction is guaranteed. It would be safer to restrict the use of chemical treatments for community buildings. Indeed, the scale of community buildings might make it more complex to change part of the bamboo elements. Another application of chemical treatment could be housing in host communities, if density is lower and risk of water contamination under control.

If chemical treatment is adopted, the main target should be a low toxicity of the products during the treatment and during the complete lifespan of the treated elements.

Safety measures for chemical preservative treatment are a priority. Basic measures:

- Wear gloves and glasses during processing.
- Keep children and animals away.
- Discard used chemicals in designated waste areas.
- **Explain that burning chemically treated wood or bamboo pieces off-cut on site produces highly toxic smokes.**

DOT dip and diffusion method

Treatment with DOT (or Disodium octaborate tetrahydrates)is one of the less toxic chemical treatment methods. A simple method for DOT treatment is the dip + diffusion process (also used for wood treatment):

Preparation of the bamboo :

Green bamboos are cut to the required length. For bamboo culms : the nodes are perforated so that the solution gets in contact with all parts of the culm (this won't affect the resistance of the bamboo)

Soaking :

Bamboo culms or bamboo splits are soaked in a 10 % DOT solution for a few hours (for bamboo splits) to a few days (for bamboo culms). A soaking tank is built according to the scale of the treatment plant.

Diffusion :

Bamboos are wrapped in a plastic sheet for about 1 week so that the solution can be completely absorbed.

Drying process is recommended after the treatment.

Quality control: it is possible to test the actual diffusion of DOT in the bamboo / wood by applying dye and revealing solution after drying. It allows to have a systematic quality control process and to monitor the leaching of the chemical.

There are other methods of preservation with DOT. The *Boucherie* method is recommended for large scale treatment, but requires specific tools and machinery.

NB: DOT is a waterborne solution, so if it is not applied properly and if the building design is not correct, it might be leached and contaminate the water.

Protection coatings

Applying chemicals on bamboo culms is only superficial due to composition of the external skin of the bamboo. It is possible to apply a protective coating.

Buried parts are commonly coated with burnt motor oil. But in the case of shelter camps, soil and water pollution (and then poisoning of the population) should be strictly avoided. Burnt oils contain heavy metals and other dangerous elements. During service, the additives in lubricating oils are changed or consumed, and the oil itself becomes contaminated from both internal and external sources.

Top:

Recommendations on design for longer lasting of components

The durability of any material is mainly depending on the design. Bamboo, wood, thatch or mud should also be considered as building materials that require specific details. Local know-how should be observed as a valuable source of information.

Raise bamboo or wood from the ground

Appropriate footing or plinth is the key point . If bamboo is protected from soil humidity and insect attacks, it will last longer than treated bamboo without proper footing (and much longer than untreated bamboo with inappropriate footing).

▪ A common practice is to setup the bamboo post on a RCC *Kathla*. These RCC precast elements constitute the foundation of the structure. The bamboo post is tied to it. A prepared bamboo post + *Kathla* may replace a RCC post.

▪ An another option is to build a masonry plinth to raise the bamboo structure. The bamboo structure should be grounded using a rope or PP strap to avoid uplift of the structure due to wind load.

Dissociate bamboo or wood structure from masonry

A common practice is to place a brick between the masonry and the bamboo structure to:

▪ Avoid humidity transfer from the masonry plinth. The bamboo elements dry faster, and it avoids residual water between masonry and beam / post.

▪ Limit termite paths and make them obvious. It is a way to control the termite attacks. Termites hide from daylight. If they can makes paths in the materials (mud, wood bamboo for instance) without crossing any void or hard element, there is no way to identify their path nor their presence in the materials (before it is too late). But if they are forced to build external paths, which makes it easier to react.

Protect bamboo from humidity

A cheap way of protecting a bamboo post from humidity, but not as durable as raising from the ground, is to wrap the bamboo foot in polythene before it is put in the ground. In addition, filling the hole around the bamboo foot with sand and brick chips drains the water away from the bamboo. The limit is that humidity can migrate in the bamboo post and can get trapped in the plastic wrapping (without possibility of drying).

Protect bamboo from direct sun / rain

Duration of bamboo also depends on the protection from rain and direct sun. Structural elements should be protected So as much as possible from these solicitations. For instance all beams and posts should be protected by walls and/or fence. For bamboo bridges for instance a roof is highly recommended.

Dissociate roofs

When adding a roof (for instance when a veranda is built), it is recommended to disconnect the structures: if one part is infested it is possible to see the termite paths and react. And if necessary to change the infested part in time.

NB :Dissociating the roofs is also recommended for limiting the damages in case of strong winds.

Findings

Treatments do increase the pest resistance of the poles, but most bamboo species have very low durability if they are in direct contact with the ground and such treatments provide far less protection than a raised footing.

Related information

Adhikary, N. Experiment with a locally constructed boucherie treatment plant in Nepal. Retrieved from http://abari.earth/treatment

Garnier, P., Le Gall, O., Hosta, J.(2017) Wood treatment guideline DOT dip diffusion. retrieved from http://www.asfnepal.org/wp-content/uploads/2018/02/Wood-Treatment-Guideline-13092017.pdf

Hodgkin, D.(2009). A manual on the humanitarian use of bamboo in Indonesia. Humanitarian Bamboo. Retrieved from http://humanitarianbamboo.org/wp-content/uploads/2010/04/Humanitarian%20Bamboo%20Draft%202%20medium.pdf

Housing and Building research institute. (2015) "Bangladesh National Building Code 2015 final draft. Retrieved from http://www.apscl.com/download/Bangladesh%20National%20Building%20Code-2015%20Vol_1_3%20(Draft).pdf

Schröder, S.(2012). When and How to Harvest Bamboo, in *Bamboo cultivation*. Retrieved from https://www.guaduabamboo.com/cultivation/when-and-how-to-harvest-bamboo

8.7 Also Implement housing programs in host communities

Housing situation in the host communities is also problematic. As mentioned there is a severe lack of community buildings and serious risks of land erosion.

The recommendations and technical proposals above could be applied to housing programs in host communities (see 9.1 to 9.6)

Slope consolidation

Slopes erosion got worse with the very sudden and massive arrival in the region : hill cuts and need for cooking fuel have a bad impact on slope stability.

So the preexisting needs to work on slope consolidation is even more acute. Train the population on bio-technical measures for soil protection could be a relevant solution (see part 9.3).

Repair and improve when possible

Repairing the existing houses has proven its efficiency :

- Land available for construction is rare, so building new constructions is frequently a challenge.
- Training the population on repairing and maintenance reinforces its resilience.
- Low investment can provide important results.

Build demo low cost houses

There is also a demand for building new houses, or to replace shelters by more durable housing solutions. The construction of low cost demo houses would be a good opportunity to share options and develop solution with the host communities.

Use demo construction of community buildings for the training of local artisans

As there is a lack of community infrastructure, organizing the construction of community building as a training would offer the double advantage of responding to a demand and offering capacity building activities. The strategy of starting with community building for the training of local artisans might increase the appropriation of the population.

Previous page
Top:
Overveiw of the land erosion in a host community, Sofiulah katah
Middle:
Examples of community buildings in Bangladesh, built with local materials and skills: METI handmade school & DESI vocation school, Anna Heringer
Bottom:
Weaknesses in the connection between construction steps can be observed: training could help builders to improve construction quality, using the technolgies they are used to.

8.8 Develop practical training strategy

Considering the scale of the shelter response it is necessary to go on developing a practical training strategy. **It is important to invest in inhabitants and local professionals' empowerment.**

In order to reach the largest part of the population and the expected quality for the shelter response and the housing programs in host communities, it is recommended to continue the training including:

Training of trainers

Participants:

▪ Skilled carpenters, skilled masons and architect/ engineers from displaced population and host communities.

▪ Able to facilitate and good communication skills.

Type of training:

Theoretical including practical exercises.

Expected results:

Participants are trained to train semi-skilled carpenters and masons in:

▪ Mid-term shelter constructions;

▪ Community buildings;

▪ Repairs and construction of low cost houses

▪ Slope stabilization, including bioengineering approaches

Training of carpenters and masons

Participants:

▪ Semi-skilled carpenters and masons.

Type of training:

Practical including theoretical sensitizing

Expected results:

▪ Trainees are able to lead and organize a shelter construction, giving the appropriate instructions to semi-skilled and unskilled builders.

▪ Trainees are able to work on a community building and on slope protection.

Training of community members

Participants:

▪ Displaced populations, refugees and host community inhabitants including informal masons and carpenters.

Type of training:

Practical training and sensitizing

Expected results:

▪ Trainees understand the main technical works for the construction of a mid-term shelter, assisted by a mason / carpenter.

▪ Trainees understand and master common repairing and maintenance activities for drainage and mid-term shelter, principles of slope stabilization principals. They understand the good practices for extending their house / shelter.

9. Annexes

9.1 Key informants

Organization	Key informant
RRRC	Md. Shamsud Douza (Deputy secretary)
CRS	Federico Rota
ECHO	Tapan Mahapatra Suranga Mallawa (Surge Respons expert)
IOM	Keisuke Kamiya
UNHCR	David O'Merara (Snr Shelter officer)
Shelter/NFI Sector	Hani Chatila (Coordinator) Ratan Kumar Podder (co-coordinator) Tonja Klansek (Technical coordinator)
Caritas regional office (Cox's Bazar)	Mazharul Islam (Head of program)
CIC	Assistant (Camp 3)
Caritas field office (Ukhia)	Ing. Abu Tahir (focal person Ukiya level / UU zone coordinator)
Obat helpers	Immad Ahmed (executive director)
Brac	Md Delowar Hosain
TNO	Md Nikarzzaman Choudhorl
Palong Khali Chairman	Goffur Uddin Chudhry
Rajapalong Union Ukhia Chairman	Md Jahangir Kabir Choudhory

9.2 Assessment formats

Assessment for shelter needs under the emergency response program of Caritas Bangladesh
Data Collection Survey Form (For Using in Public Meeting)

NOTE FOR IMPLEMENTATION:
Analysis stage: initial
Time required: 2h30
Number of participants: 20-30 persons
Type of participant: members of community (various ages and ethnical/cultural/economic backgrounds)
Equipment: check list, writing pad, pen
Team members: 2 (1 facilitator + 1 observer)

Introduction: presentation of the programme, explanation of objectives, request of participation

"My name is …… and currently, I am working with Caritas Bangladesh in …… area in order to reduce damage to shelters during disasters with the local people. This is why, we have taken initiative to conduct survey on households. You have been selected to conduct this survey. The purpose of this survey is to obtain experience of shelter construction. We will be able to know and learn something from you with this survey. Please do not presume that you will get any kind of benefits or compensation for this interview. This is only for our knowledge. This survey is consensual and you can refuse to participate if you wish. A report will be created with this information. I would like to take 1 hour from you for conducting this survey and I would like to ask some questions."
(P.S. Do not suggest that any kind of social and domestic benefits will be gained from this survey; otherwise they can direct the answers)

1. General information about the area:

1.1. Description of location

Please describe the topography (Plain Land, hilly, etc.)?
What are the main seasons observed in the area?

1.2. socio-economic profile

What is the population of the camp zone?
What is the number of households?
What is the average number of persons per households? for large family / For medium family /For small family

1.3. Infrastructures/facilities

Number of schools?
Number of community "buildings"?

1.4. Health:

Number of health centre?
Source of clean water
Type of latrine people use
Type of diseases present?

1.5. Occupation

What type of activities are the inhabitants able to develop (general and for construction)
What are the source of income and livelihood?
What are the activities taking place in the shelter?

2. Main features of shelters:

2.1. Settlement pattern

How are the shelters distributed?
How are the shelter gathered? (Are there any link between neighbours?)
What is the land ownership?

2.2. Plot

Is there any type of vegetation around?
What are the solutions for drainage?
What are the solutions for soil stabilizations?

2.3. Shelter pattern

What are the main types of shelters observed?

2.4. Architectural typologies

What are the main dimensions of the shelters?
What are the different shapes of shelters?
What is the number of rooms, orientation, and space arrangement?
Is the cooking place within the shelter or outside? Why?
Where are most of the houses faced? Why?

2.5. Building components

Building component	*Material used*	*Dimensions*	*Characteristics*
drainage			
Foundation/Plinth			
Pilar			
Wall / Fence			
Truss			
roofing			
Openings			
other			

2.6. Building materials

Building material	*Available? Provenance?*	*Dimensions*	*Characteristics*
Wood			
Bamboo			
stone			
mud			
thatch			
tarpaulin			

CGI			
Nails *Rope*			
Wire			
other			

2.7. Problems in the shelter

What are the main difficulties faced: land, spaces, materials, transport, artisans, etc.?

2.8. Maintenance

Construction part	*Frequency*	*Cost*	*In charge*
Foundation / plinth			
Pillars			
Fence			
Ceiling			
Roofing			
Mud walls			

What is the average lifespan of a shelter?

2.9. Extension of living space

Are there any extensions of the living space? (If yes which part? where? When? By whom?)

2.10. Comfort

What are the main problem concerning comfort in the shelter:

Climate?
Privacy?
Security?

3. Construction process:

3.1. Season for construction

3.2. Transport of materials

What is the major mode of transportation in the camp?

3.3. Preparation of materials

Is there any method of maintaining the quality and durability of the materials? How are they done?

3.4. Construction steps

How many steps are taken to construct the shelter? (If several steps, please detail)

3.5. Duration of construction

What is the average duration of shelter construction?

3.6. Ways to reduce costs

Approximate expenditure to construct a complete shelter
What steps are taken to reduce the expenditure?

3.7. Who do what for the construction

How are the householders involved in the construction of the shelters?
Do they receive any technical help?
Are there workers under contracts for the construction of shelters?
What is the relation between households and artisans?

	Daily wage
Masons	
Carpenters	
labourers	

3.8. Decision criteria for construction

What are the main criteria for:
The choice of the site?
The materials used?
The space arrangement?

4. Natural hazards

NB: For new arrivals, with no experience on local natural hazards, the next questions concern the interviewed homeland experience

4.1. Main features:

What kind of disasters generally occur?
With which frequency (ordinary & exceptional disasters)? And during which season?
What disasters make the more damages?
After how much time does the situation go back to normality?
Which is the most exposed part of the area?
What about the access to the area?

4.2. Collective measure for vulnerability reduction

How do you get early warning of disaster?
What are the arrangements to improve resistance of the shelter?
What do people do before, during and after a disaster?
Where do people take shelter during disasters?
What are the main difficulties people are facing after a disaster?

4.3. Individual measure for disaster reduction

What are the particular arrangements to improve resistance of the shelter?
What do you do to overcome challenges during and after disasters?
What are people's priorities? Is it more important to protect their belongings? Food? NFI?
Or to preserve the shelter? In this case which part of the shelter is considered more valuable?

4.4. Situation after a disaster

What are the materials available in the area?
Are there materials from destructed shelter available for reemployment / recycling?

4.5. Damages to buildings

What are the main damages observed after a disaster?
Types of damages?
Which part is the most affected?
What is to be repaired? Rebuilt?
What would you do to make your house resilient to disasters/floods/cyclones?

5. Additional information:

5.1. Other GO/NGO working in the area (types of activity, aid in disaster situation)

Which NGOs are working in the area and which ones work in housing?
What kind of shelters do they make?
What kind of help do they provide after a disaster situation?

5.2. Local and community-based organisation

Data Collector

Name	
Signature	
Designation	
Date	

NOTE FOR IMPLEMENTATION:

Individual shelter survey is based on a technical assessment as well as on an interview with shelter / house owner and/or inhabitant. These two parts can be done in the same time or one after the other. Time required depends on people availability and complexity of the construction. The tools for this analysis steps are two and can be used separately to complete the information already acquired. The technical questionnaire is for construction assessment and detailed questionnaire for interview; however both will require some participation from the inhabitants. After having completed the survey of some shelters / houses, detailed survey could also be done without technical part to get some more information about construction process, coping strategies and disaster impact on shelter / housing.

- Analysis stage : intermediate
- Time required : 1h-2h (0h30-1h00 for interview + 0h30-1h00 for technical assessment)

TECHNICAL QUESTIONNAIRE

- Number of participants: 1-2 persons
- Type of participant: team members
- Equipment : questionnaire, writing pad, pen, meter, camera
- Team members: 1-2 persons

DETAILED QUESTIONNAIRE

- Number of participants: 1-2 persons
- Type of participant: house owner, inhabitants, builders
- Equipment : questionnaire, writing pad, pen
- Team members: 1 person

Questionnaire for Assessment Survey of Existing Shelter / TECHNICAL PART

1	Sample ID	Village / No. of the shelter		Surveyor	Date
2	Address				
3	Owner / interviewed person detail	Name		Age	Profession
		No of adults	No of Children		No of domestic animals
		M: F:	B: G:		
4	Plot situation	Land	Risks	Vegetation	Built environment
		○ Flat ○ Slope ○ Top of the hill ○ River/lake side ○ Other	○ Wind exposed ○ Unstable slope ○ Flood exposed ○ Tidal wave exposed ○ Other	○ No tree ○ Isolated trees ○ Some trees ○ Surrounded	○ Isolated house ○ Near other houses ○ Between other houses ○ Other
5	Location of the shelter	Distance from river, sea, ravine, …	Orientation	Position on the plot	Other constructions
6	House typology	Type	No. of Rooms	Particular elements	
			○ 1 ○ 2 ○ 3 ○ 4	○ veranda ○ kitchen ○ cattle shed	
7	Dimensions	External perimeter	External heights	Rooms	Room Height
			Ridge: Gutter (if any): Walls :		
8	House age and condition	Age, yrs	Condition	Maintenance (building parts and frequency of works)	
		○ <1 ○ 1 to 2 ○ 2 to 5 ○ >5 ○ other	○ Old but maintained ○ Old and damaged ○ New but not maintained ○ New and maintained ○ Other		
9	Facilities & equipments	Latrine	Water supply source		
			Type	Access	Distance (time)
			○ well ○ pond ○ pump ○ other	○ easy ○ difficult ○ very difficult ○ other	

11.	Assessment of the Structure	Structural system	Framing: timber/bamboo/other Fence/infill:		Masonry: Mud walls/ mud bricks / mud + cement wall / other
		Foundation	Type:	Level of plinth	Soil condition
				ft from existing ground level	
		Post (size, spacing)			
		Beam (size, spacing)			
		Cross bracing sizes (location, types)			
		Roof	Flat / 1 pitch / 2 pitches / 4 pitches / other Structure: Timber/Bamboo/Steel Covering: GI sheet / thatched / shelter grade tarpaulin / non shelter grade plastic / other		
		Connections			

		Opening	
		Special arrangements	Furniture?
12.	Experience of last disaster: o extreme storm o rainfall o earthquake o flash flood o land slide o other	Duration	
		Rainfall	o mild o moderate/submerged o strong o very strong (washed away)
		Force of wind	o Mild o Strong o very strong(trees, houses uprooted)
		Main wind direction	
		Water level	o under plinth level o over plinth level o other o
		Damages	
14	Draw sketches	House plan, sections and elevation / details (note the most important dimensions)	

Questionnaire for Assessment Survey of Former house / TECHNICAL PART

<table>
<tr><td>1</td><td>Sample ID</td><td colspan="2">Village / No. of the shelter</td><td colspan="2">Surveyor</td><td>Date</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">House typology</td><td>Type</td><td>No. of Rooms</td><td colspan="3">Particular elements</td></tr>
<tr><td></td><td>o 1
o 2
o 3
o 4</td><td colspan="3">o veranda
o kitchen
o cattle shed</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Dimensions</td><td>External perimeter</td><td>External heights</td><td>Rooms</td><td colspan="2">Room Height</td></tr>
<tr><td></td><td>Ridge:

Gutter (if any):
Walls :</td><td></td><td colspan="2"></td></tr>
<tr><td rowspan="3">9</td><td rowspan="3">Facilities & equipment’s</td><td>Latrine</td><td colspan="4">Water supply source</td></tr>
<tr><td rowspan="2"></td><td>Type</td><td>Access</td><td colspan="2">Distance (time)</td></tr>
<tr><td>o well
o pond
o pump
o other</td><td>o easy
o difficult
o very difficult
o other</td><td colspan="2"></td></tr>
<tr><td rowspan="4">11.</td><td rowspan="4">Assessment of the Structure</td><td>Structural system</td><td colspan="2">Framing:
timber/bamboo/other

Fence/infill:</td><td colspan="3">Masonry:

Mud walls/ mud bricks / mud + cement wall / other</td></tr>
<tr><td rowspan="2">Foundation</td><td>Type:</td><td>Level of plinth</td><td colspan="2">Soil condition</td></tr>
<tr><td></td><td>ft from existing ground level</td><td colspan="2"></td></tr>
<tr><td>Post
(size, spacing)</td><td colspan="4"></td></tr>
</table>

		Beam (size, spacing)	
		Cross bracing sizes (location, types)	
		Roof	Flat / 1 pitch / 2 pitches / 4 pitches / other Structure: Timber/Bamboo/Steel Covering: GI sheet / thatched / shelter grade tarpaulin / low grade plastic / other
		Connections	
		Opening	
		Special arrangements	Furniture?
14	Draw sketches	House plan, sections and elevation / details (note the most important dimensions)	

Questionnaire for Assessment Survey of Existing Local Houses / DETAILED PART

1	Sample ID	Village / No. of the house	Surveyor	Date
2	Construction process	Who built the shelter? (How many persons? Labour cost, who did what?) o owner o skilled labour o unskilled person o family and relatives o other:		
		Did you get any assistance for o Materials o Tools o Construction work (incl. drainage o Equipment o maintenance o other:		
		Ways for reducing cost o participation to the construction o collecting materials o involving family members/relatives o self-help group o other:		
3	Construction (for the surveyor and for the shelter owner)	Shelter age		
		Criteria of choice for position/ orientation		
		Cost (total, most costly part)		
		Weakness (frequent problems and causes)		
		Strengths/ good features		
4	Construction stages	if extension, which part, in which direction? After how much time?		

5	Materials	Types, quality and building part for which it is used			
		Criteria of choice			
		Provenance and distance/ availability/ cost o land of the house owner o nearby the village o local market o other:			
6	Maintenance/ improvement (to be done and that could suggested)	Which part needs maintenance?	Frequency	What has to be done? How? By whom?	Cost
7	Disaster o extreme storm o rainfall o earthquake o flash flood o river flood o land slide o other	Does your family feel safe in the current house?			
		Where do you shelter?	o Stayed home o Embankment/road o Shelter/school o other		
		How do you prepare to a disaster?			
		Description (duration, after how much time situation returns normal, how do you manage)			
		Damages to buildings			
		Damages to surrounding environment			
		Is it possible to make the house safer? How?			

		(at house level, surrounding environment, trees more resistant)	
	Priorities for improvement	○ Water access ○ Latrine access ○ Kitchen ○ Thermal comfort ○ Drainage ○ ○ Dimensions ○ # of rooms ○ other	
8	Sketches	House (function, space arrangement) + surrounding environment (trees, other houses, plot arrangement)	

NOTE FOR IMPLEMENTATION:
Analysis stage: final
Time required: 1h-2h
Number of participants: 3-4 persons
Type of participant: artisans (mason, carpenter, etc.) involved in house & shelter construction in the area and in the former location
Equipment : check list, writing pad, pen
Team members: 2 (1 facilitator + 1 observer)

Introduction: presentation of the programme, explanation of objectives, request of participation

"My name is …… and currently, I am working with Caritas Bangladesh in …… area in order to reduce damage to shelters during disasters with the local people. This is why, we have taken initiative to conduct survey on households. You have been selected to conduct this survey. The purpose of this survey is to obtain experience of shelter construction. We will be able to know and learn something from you with this survey. Please do not presume that you will get any kind of benefits or compensation for this interview. This is only for our knowledge. This survey is consensual and you can refuse to participate if you wish. A report will be created with this information. I would like to take 1 hour from you for conducting this survey and I would like to ask some questions."
(P.S. Do not suggest that any kind of social and domestic benefits will be gained from this survey; otherwise they can direct the answers)

1. Housing technical features

1.1. Houses types and dimensions

1.2. Building components

Building component	*Material used*	*Dimensions*	*Characteristics*
Drainage			
Foundation/Plinth			
Pilar			
Wall / Fence			
Truss			
Roofing			
Openings			

1.3. Building materials

Building material	*Available? Provenance?*	*Dimensions*	*Characteristics*
Wood			
Bamboo			
stone			
mud			
thatch			
tarpaulin			
CGI			
Nails			
Rope			
Wire			
other			

1.4. Cost of building components

Construction part	*Duration*	*Cost*	*In charge*
Foundation / plinth			
Pillars			
Fence			
Ceiling			
Roofing			
Mud walls			

2. Construction process:

2.1. Season for construction

2.2. Transport of materials

What is the major mode of transportation in the camp?

2.3. Preparation of materials

Is there any method of maintaining the quality and durability of the materials? How are they done?

2.4. Construction steps

How many steps are taken to construct the shelter? (If several steps, please detail)

2.5. Duration of construction

What is the average duration of construction?

2.6. Who do what for the construction

Decision maker in the construction process?
How are the householders involved in the construction of the shelters?
Do they receive any technical help?

2.7. Problems for construction

What are the main problems for the artisans in the construction process?

2.8. Maintenance

Construction part	*Frequency*	*Cost*	*In charge*
Foundation / plinth			
Pillars			
Fence			
Ceiling			
Roofing			
Mud walls			

3. Skills for construction:

	Number of workers available
Masons	
Carpenters	
Labourers	
other	

3.1. Number and types of artisans available

Do workers of different occupation stay and work in the area all year long?
If they have to go elsewhere, where they go and for how long? (Especially during disasters)

3.2. Daily salary / contract basis

	Daily wage (applicable?)
Masons	
Carpenters	
Labourers	
other	

1. Contract with inhabitants (applicable?)
Are there workers under contracts for the construction of shelters?
What is the relation between households and artisans?

3.3. Artisans groups

Is there any group of artisans? If they do, then how many masons are there in a group?

3.4. Exchange among artisans

What kind f of exchanges exists between the artisans? (Informal training from the elders, etc.)

Do the masons in the area discuss about the problems of the existing works and new works? Yes/No

3.5. Follow up of the construction

Who is in charge of the following of the constructions?
Do the masons assess the house after it is constructed? Yes/No

4. Natural hazards:

NB: For new arrivals, with no experience on local natural hazards, the next questions concern the interviewed homeland experience

4.1. Main features:

What kind of disasters generally occur?
With which frequency (ordinary & exceptional disasters)? And during which season?
What disasters make the more damages?
After how much time does the situation go back to normality?
Which is the most exposed part of the area?
What about the access to the area?

4.2. Collective measure for vulnerability reduction

What are the arrangements to improve resistance of the shelter?
What do people do before, during and after a disaster?
Where do people take shelter during disasters?
What are the main difficulties people are facing after a disaster?

4.3. Situation after a disaster

What are the materials available in the area?
Are there materials from destructed shelter available for reemployment / recycling?

4.4. Damages to buildings

Building component	*Type of damage*	*level of damage (high /medium / low)*	*Repaired?*	*Rebuilt?*
Drainage				
Foundation/Plinth				
Pilar				
Wall / Fence				
Truss				
Roofing				
Openings				

4.5. Improvements

What would you do to make the construction more resilient to disasters/floods/cyclones?

Data Collector

Name	
Signature	
Designation	
Date	

1. Data: Name of the company Name of person
Address & contact

2. Company characteristics:
Sector: formal/ informal years of existence #of employees
Managed by: family / community / government / other:

3. Products

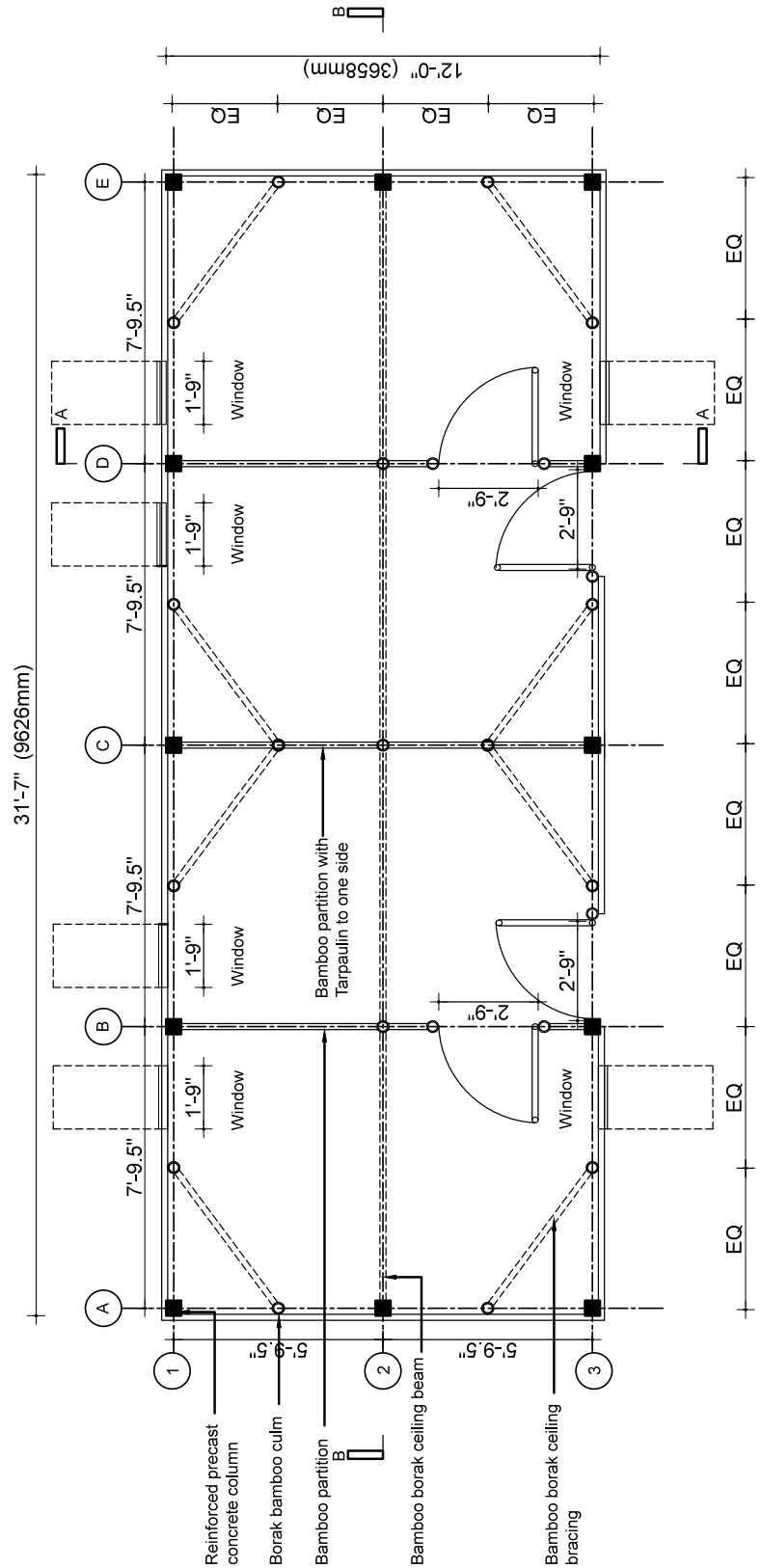
Types & dimensions	Provenance	Price	Quality	comment

For each product, consider also:
Availability, production and price variation according to season;
Available stock, production capacity, price

4. In the past (major influx of people):
-Did the production have been suspended? Y/N if yes, why and how long
-Any problem for supply of raw materials?
-how long to rebuild the stock?
-Increasing of prices:

9.3 Mid-term for displaced citizens of Myanmar Option 2 (2 units) drawings

OPTION 2



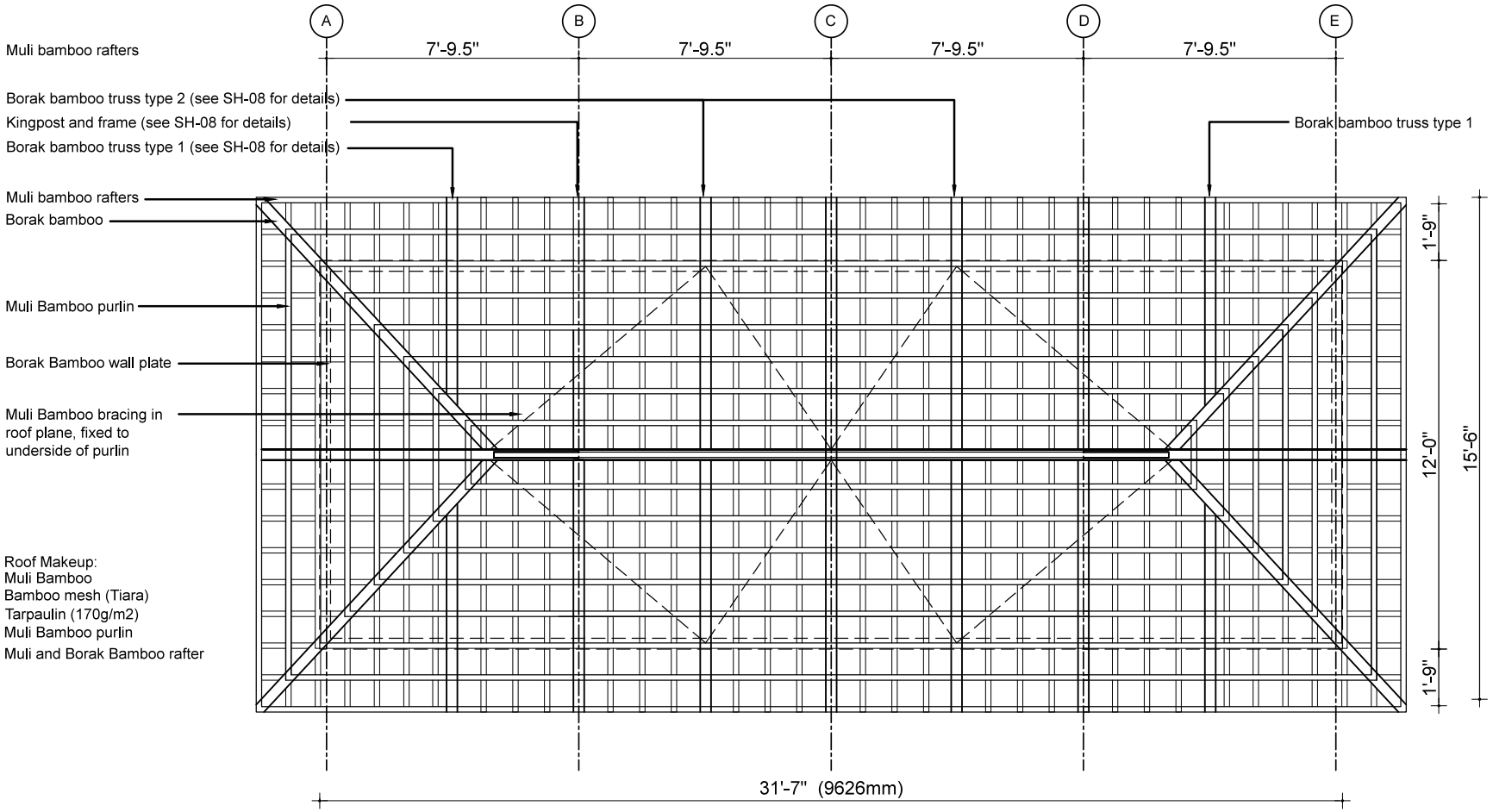
SIGNATURE

* Dimensions are indicative and to be adjusted to site condition

DESIGNED BY: CARITAS BANGLADESH / CRS	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR	PAGE TITLE: PLAN	PREPARED BY: JH	APPROVED BY: RRRC	A
RECOMMENDED BY: SHELTER AND NFI SECTOR	For Construction: MAY 2018	DWG NUMBER: DH-01	NOTED BY:		SHEET NO: 1 | 7
		SCALE: 1:40 @ A3			

SHELTER/NFI SECTOR

OPTION 2

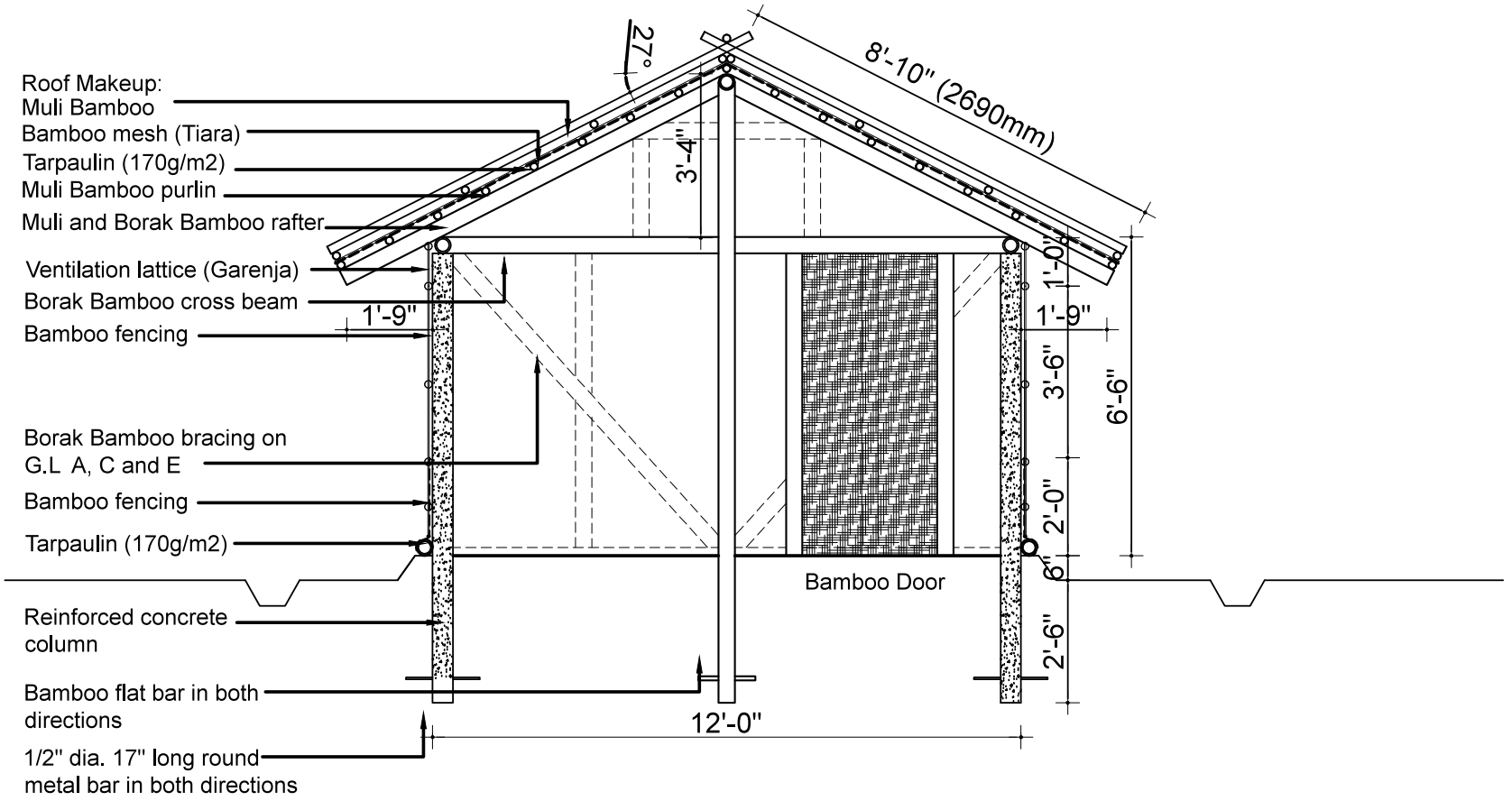


SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY: CARITAS BANGLADESH / CRS	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR	PAGE TITLE: ROOF PLAN	PREPARED BY: JH	APPROVED BY: RRRC
RECOMMENDED BY: SHELTER AND NFI SECTOR	For Construction: MAY, 2018	DWG NUMBER: DH-02	NOTED BY:	A / SHEET NO: 2 7
		SCALE: 1:40 @ A3		

OPTION 2

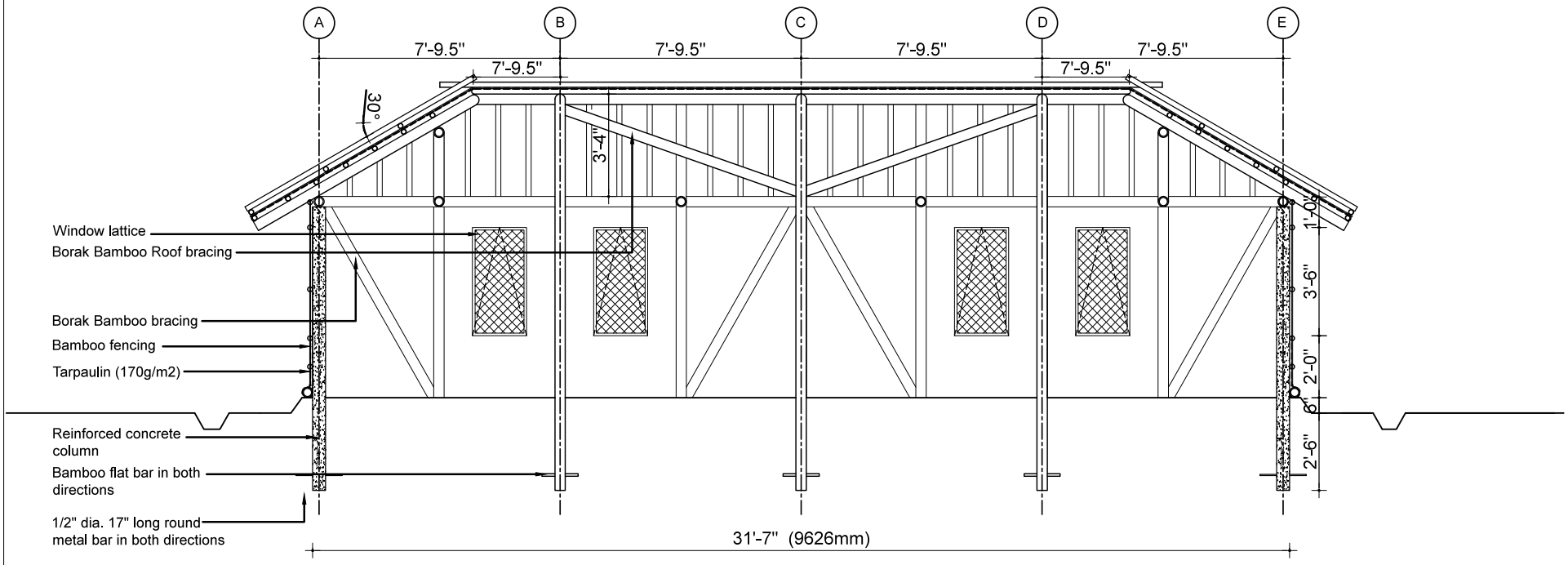


SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY: CARITAS BANGLADESH / CRS	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR	PAGE TITLE: SECTION A	PREPARED BY: JH	APPROVED BY: RRRC	A
RECOMMENDED BY: SHELTER AND NFI SECTOR	For Construction: MAY, 2018	DWG NUMBER: DH-03	NOTED BY:		SHEET NO: 3 7
		SCALE: 1:40 @ A4			

OPTION 2

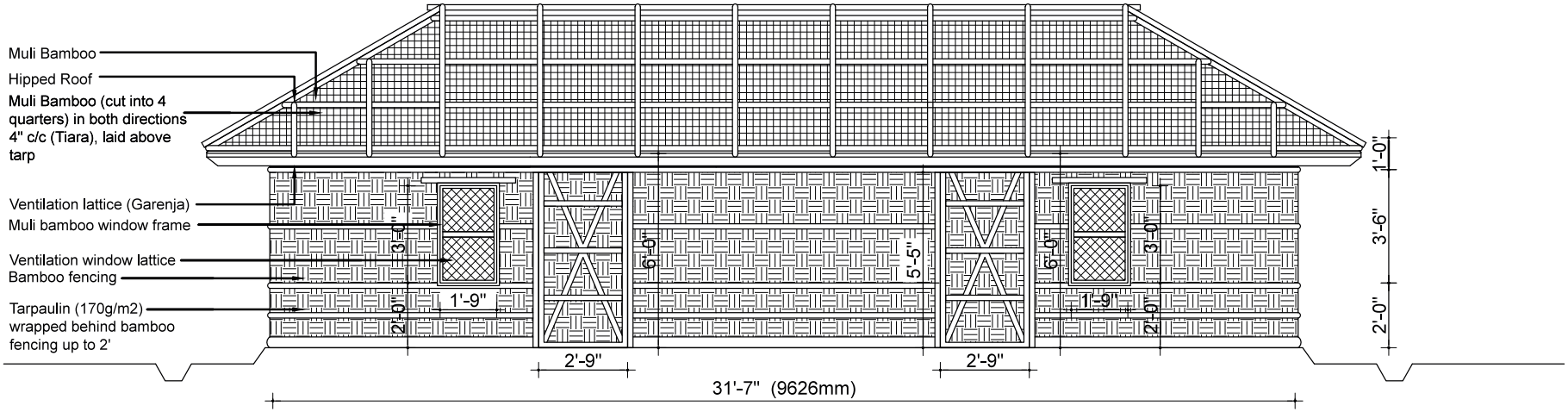


SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY: CARITAS BANGLADESH / CRS	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR	PAGE TITLE: SECTION B	PREPARED BY: JH	APPROVED BY: RRRC	A
RECOMMENDED BY: SHELTER AND NFI SECTOR	For Construction: MAY, 2018	DWG NUMBER: DH-04	NOTED BY:		SHEET NO: 4 7
		SCALE: 1:40 @ A3			

OPTION 2

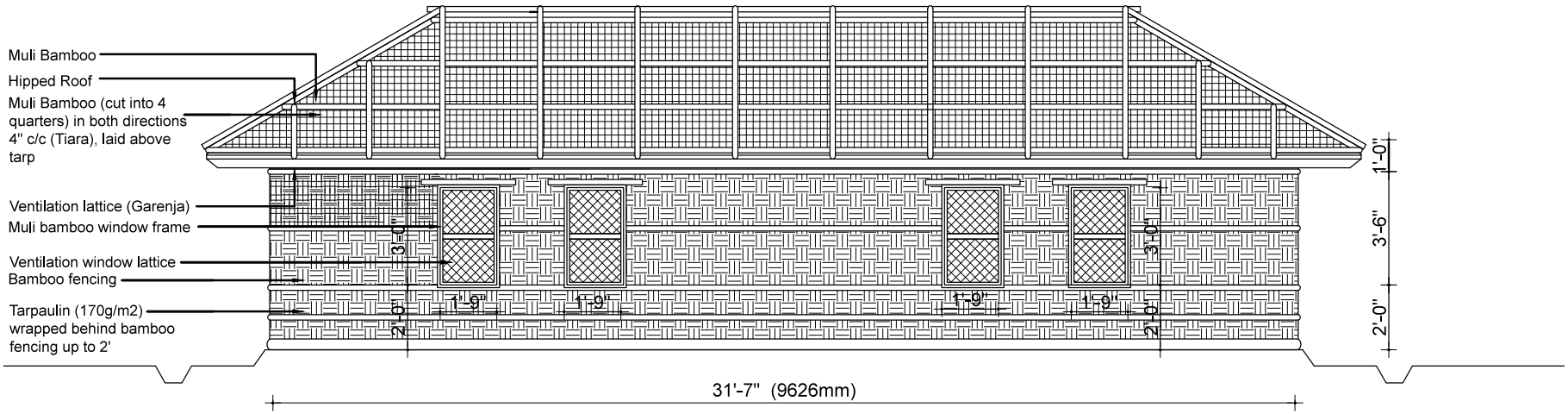


SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

ISCG | Inter Sector Coordination Group; RRRC; SHELTER/NFI SECTOR; CARITAS BANGLADESH; CRS CATHOLIC RELIEF SERVICES	DESIGNED BY: CARITAS BANGLADESH / CRS RECOMMENDED BY: SHELTER AND NFI SECTOR	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR For Construction: MAY, 2018	PAGE TITLE: FRONT ELEVATION DWG NUMBER: DH-05 SCALE: 1:40 @ A3	PREPARED BY: JH NOTED BY:	APPROVED BY: RRRC	A SHEET NO: 5 7

OPTION 2

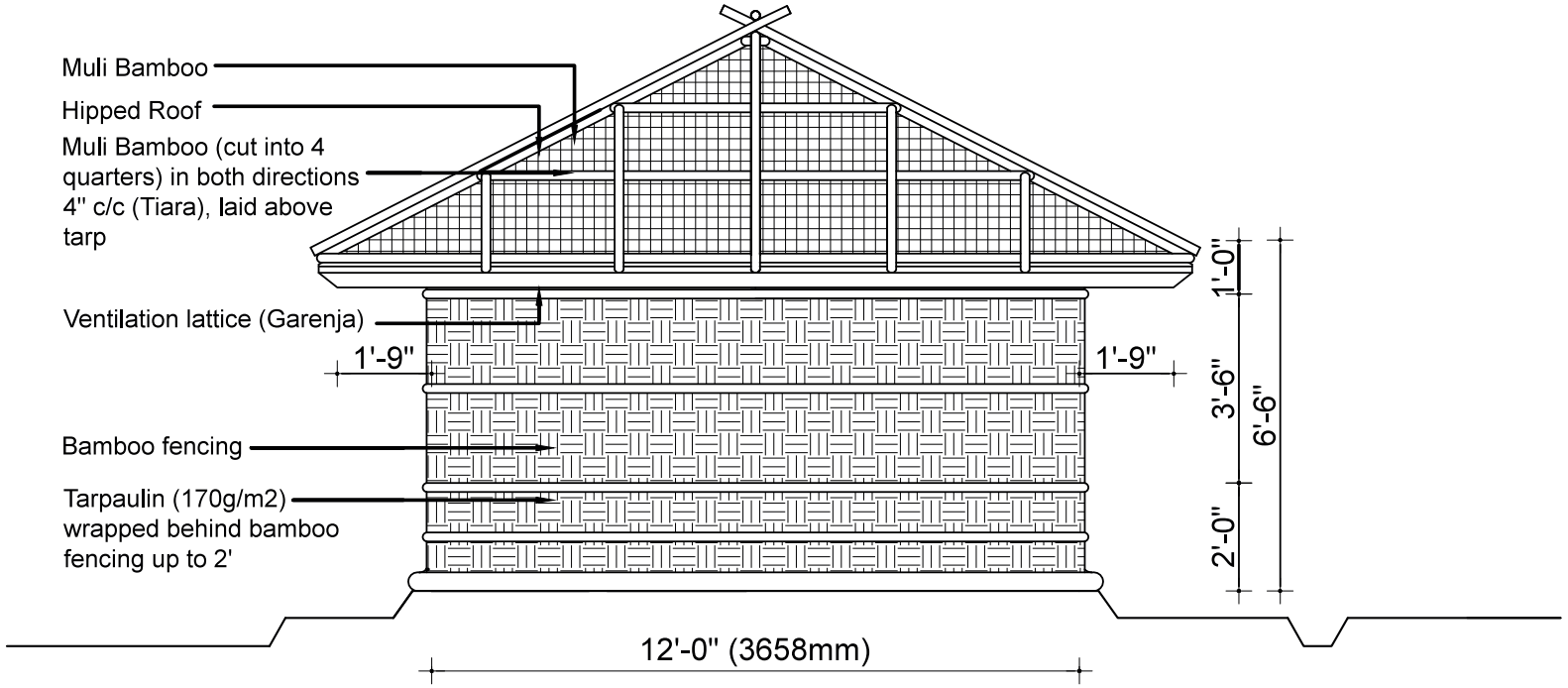


SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY:	PROJECT TITLE:	PAGE TITLE: BACK ELEVATION	PREPARED BY:	APPROVED BY:	A
CARITAS BANGLADESH / CRS	MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR	DWG NUMBER: DH-06	JH	RRRC	SHEET NO: 6 7
RECOMMENDED BY:			NOTED BY:		
SHELTER AND NFI SECTOR	For Construction: MAY, 2018	SCALE: 1:40 @ A3			

OPTION 2



SIGNATURE

*** Dimensions are indicative and to be adjusted to site condition**

DESIGNED BY: CARITAS BANGLADESH / CRS	PROJECT TITLE: MID-TERM SHELTER FOR DISPLACED CITIZENS OF MYANMAR	PAGE TITLE: GABLE ELEVATION	PREPARED BY: JH	APPROVED BY: RRRC	A
RECOMMENDED BY: SHELTER AND NFI SECTOR	For Construction: MAY, 2018	DWG NUMBER: DH-07	NOTED BY:		SHEET NO: 7 7
		SCALE: 1:40 @ A4			

Credits

Under the direction of:

Olivier Moles, chargé de projet, CRAterre

Author:

Julien Hosta, CRAterre

Contributors

Ratan Kumar Podder, Shelter/NFI Sector
Hani Chatila, Shelter/NFI Sector
Tonja Klansek, shelter/NFI Sector
Dr MS Islam, Bangladesh University of Engineering and Technology (BUET)
Dr Tashin R. Hossain, Bangladesh University of Engineering and Technology (BUET)
Golam Rosul, Caritas Bangladesh
Ranjon Sharma, Caritas Bangladesh
Jatin Murmu, Caritas Bangladesh
Silla Chow, Catholic Relief Services (CRS)
Federico Rota, Catholic Relief Services (CRS)
and all the key informants interviewed people (see annexe 9.1)

Photos

CRAterre (or mentionned)

Drawings

Technical drawings of the mid-term shelter option 2 : Caritas Bangladesh / Catholic Relief Services

3-D Model of the mid-term shelter option 2 :

Contact

craterre@grenoble.archi.fr

download

This document is available on CRAterre's website :
https://craterre.hypotheses.org/2498